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AUTISM'S FORGOTTEN GIRLS

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By Gina Rippon

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PLUS
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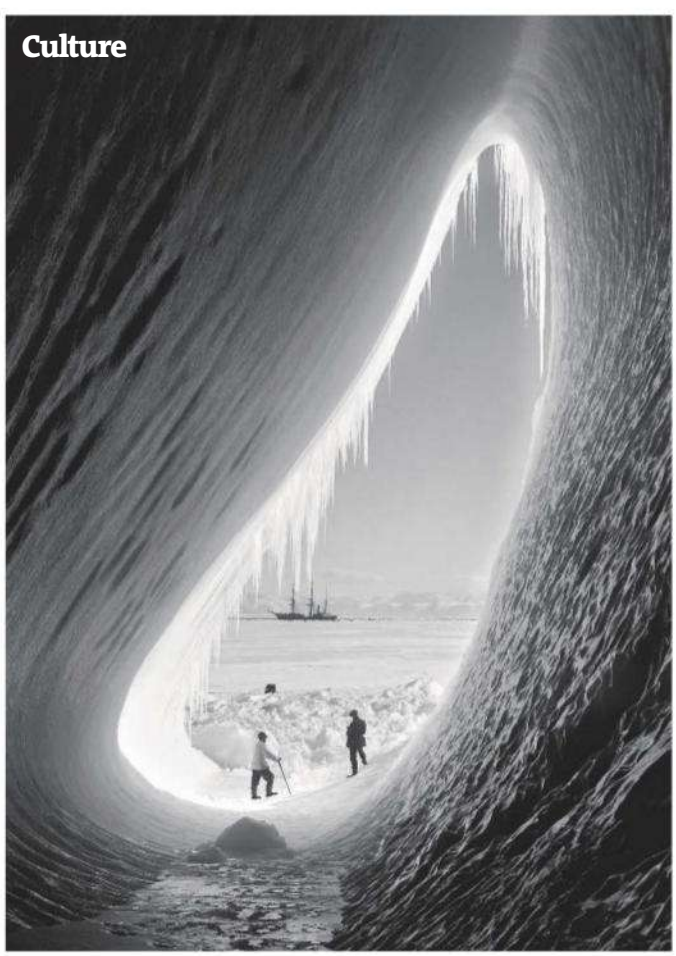

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Consciousness and the mind-body connection

Discover the intriguing links between our physical and mental worlds, such as the strange effects of placebos and nocebos, and interoception – our ability to sense the body's internal signals. Join six world-leading experts at London's Congress Hall on 26 April to find out what this all means for our future health and the mysteries of consciousness.

newscientist.com/events

Tour

Canals in the industrial revolution: England

Journey through the Birmingham Canal Navigations, a network boasting over 160 kilometres of waterways that was the lifeblood of the industrial revolution. You will be accompanied throughout by waterways expert Roger Butler, who will delve into the history and significance of these canals, visiting key sites in Birmingham and the Black Country. This seven-day tour starts on 22 June and costs £1872.

newscientist.com/tour

Podcast

Weekly

The team discuss how to have a healthy relationship with your smartphone. Hear about an abundant substance that could turn into a superacid that causes diamond rain to fall on planets in our solar system. Plus, find out about the changes that occur throughout the body during pregnancy and that may last for a long time afterwards.

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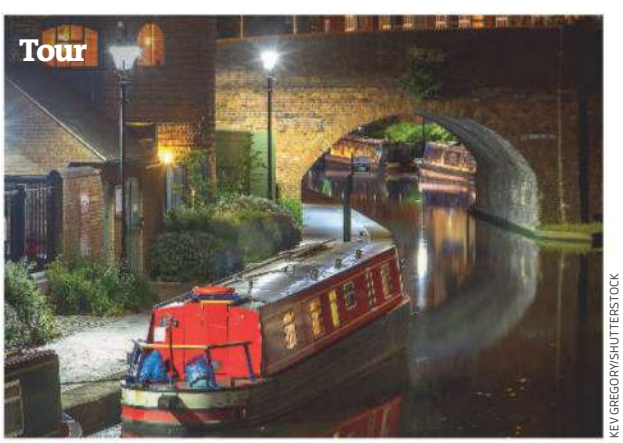
FIREFLY AEROSPACE

Blue Ghost Recent moon mission offers insights into space weather



KEV GREGORY/SHUTTERSTOCK

Industrial canals Birmingham has a longer canal system than Venice

Video

Lunar vision

Firefly Aerospace's Blue Ghost's lunar lander has completed its two-week mission and sent spectacular sunset images as a "final goodbye" back to Earth. It was the first successful commercial moon landing. The lander delivered 10 NASA science payloads of equipment to the Mare Crisium basin and transmitted 119 gigabytes of data back to Earth.

youtube.com/newscientist

Newsletter

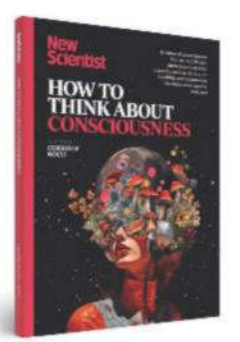
Lost in Space-Time

Worried about nothing? Physicist Antonio Padilla explains how the concept of nothing sparked a 1000-year war. Find out why nothing might also explain the mysterious dark energy that is pushing galaxies away from each other. Plus, does nothing have the potential to destroy the universe?

newscientist.com/lost-in-space-time

Podcast

"Superacid might result in diamond rain falling on planets in our solar system"



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Autistic enough

We have missed autism in girls for decades – and the time for change is now

IF YOU are having a heart attack, you had better hope you are a man. Women are 50 per cent more likely than men to be misdiagnosed when having a heart attack. The main reason? Stereotypes: we tend to think of heart attacks as a "man thing".

Autism, too, has long been seen as a condition predominantly affecting men. As with heart attacks, this perception is widely held by the public and often portrayed in cultural characterisations of autism. But it is also a self-propagating belief that has affected scientific research for decades. The more that autism researchers studied the condition, the more they looked for it in boys and men, and so their assertion that this group is most affected appeared to be increasingly validated. Autism research has focused almost exclusively on boys and men. Gold-standard diagnostic tests, too, have been designed for and validated on this group.

Girls have paid the price. Most autistic girls will reach 18 years old without a diagnosis, as neuroscientist Gina Rippon writes on page 32. Late-diagnosed women

"Women might describe a lifetime of 'diagnostic bingo' before finally getting a diagnosis"

might describe a lifetime of "diagnostic bingo" – being told they have such things as borderline personality or social anxiety disorder, before finally receiving an autism diagnosis, often late in adulthood.

But new studies of girls' brains have revealed that autism can look very different in girls and boys, revolutionising our understanding of the condition.

So what happens next? It would be nice to think this will automatically improve things for autistic girls, but we need only look at heart attacks to know it isn't that easy. We have long known that cardiovascular disease affects as many women as men, yet the "heart attack gender gap" persists. In the case of autism, the gender bias has been embedded within the research for decades. Thus, on a systemic level, we need better bias checks within the peer-review process. As for the tests currently used to diagnose autism – which often dismiss women as "not autistic enough" – a swift and radical overhaul of these would be a good place to start. ▮

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Palaeontology

Brought in from the cold

Laid down on this operating table are the remains of a 50,000-year-old baby mammoth nicknamed Yana. On 27 March, scientists performed a necropsy on Yana at North-Eastern Federal University in Yakutsk, Russia. The carcass, which was found in thawing permafrost last summer, is 2 metres long and weighs 180 kilograms.

STRINGER/AFP VIA GETTY IMAGES

Climate change

Global twist to China's cleaner air

Efforts to improve air quality in China may have inadvertently increased the rate of warming by removing the masking effect of aerosol pollution, finds **Madeleine Cuff**

A SURGE in the rate of global warming has largely been driven by China's efforts to reduce air pollution, raising questions about how air quality regulations are influencing the climate and whether we fully understand the impact of removing aerosols from the atmosphere. This extra warming, which was being masked by the aerosols, accounts for 5 per cent of global temperature increase since 1850.

In the early 2000s, China had extremely poor air quality as a result of rapid industrialisation, leading to a public outcry in the run-up to the 2008 Beijing Olympics. In response, Chinese authorities fitted scrubbers to coal power plants to curb the dirtiest emissions and tightened rules governing vehicle exhausts, leading to a 75 per cent drop in sulphate emissions.

But there is a sting in the tail of this environmental success story. According to a new analysis, China's dirty air had inadvertently been cooling the planet, and now it is gone we are starting to see a greater warming effect.

We know that warming has probably sped up in the past decade or so. Since 1970, the world had been warming at a constant rate of about 0.18°C (0.32°F) per decade, but since 2010, that seems to have increased to around 0.24°C (0.43°F) per decade, once the influence of natural climate variability is stripped out. Researchers have previously pointed the blame for this uptick in warming at efforts to curb air pollution, but until now they had struggled to pin down what contribution individual regions were making to the global trend.

Sulphate aerosols, released by burning fossil fuels, cool the planet in two ways. The particles themselves reflect sunlight back into space, shielding Earth from solar radiation. They also influence the way clouds are formed, increasing the occurrence of whiter, longer-lived clouds that also reflect radiation. Removing these aerosols from the atmosphere therefore eliminates a cooling effect.

To tease out this effect, Bjørn Samset at the CICERO Center for International Climate Research in Norway and his colleagues used newly published emissions data that gives a more accurate picture of Chinese action on aerosol pollution since 2005. They used state-of-the-art models to simulate how the climate system would respond to rapid drops in aerosol levels, specifically in China. They then compared these results with real-world data, such as satellite observations and estimates of sulphate pollution drawn from emissions reports, and found the modelled scenario was consistent with the real-world data signals.

This allowed the team to isolate the global warming impact of reductions in Chinese aerosol pollution, says Samset.

> **"Despite the impact on global temperatures, the action was worth taking to save lives"**

"When we started looking at the numbers, it turns out it is definitely macroscopic – it's not a small effect," he says. In total, China's air pollution crackdown is responsible for 80 per cent of the increased rate in global warming seen since 2010, the team concludes, around an extra 0.05°C (0.09°F) per decade. If you look at the full amount of warming since 1850, about 0.07°C (0.13°F) can be attributed to the clean-up in Chinese aerosols, around 5 per cent of the total, says Samset (Research Square, doi.org/pffh). The analysis has yet to be peer-reviewed.

Part of this can be explained by the sheer scale of air pollution reductions China has delivered, cutting sulphur dioxide emissions by around 20 million tonnes per year since the mid-2000s. But the country's air quality also has a particularly strong impact globally, says Samset. "When you emit aerosols over China, they are taken by the atmospheric circulation, transported out over the Pacific, so they spread over a large area," he says. "The same amount of emissions from India would not have had the same effect on global warming."

Satellite data has picked up a warming trend over the North Pacific in the past few years, which this new work suggests is explained by the reduction in Chinese aerosols. "If you look at the actual observations, the big temperature series... global warming has been accelerating," says Samset. "If you look at the geographical pattern of that, a major part of it is over these two patches of the North Pacific. So it fits in."

INDRANIL MUKHERJEE/AFP VIA GETTY IMAGES

Air pollution in Beijing on the eve of the 2008 Olympic Games

Double-edged sword

It is important to note that China's action hasn't caused additional warming, Samset stresses. Rather, it has "unmasked" what was already there. "The warming was always there, we just had some artificial cooling from pollution, and in removing the pollution we are now seeing the full effect

of the greenhouse-gas driven warming," he says.

Despite the impact on global temperatures, the action was worth taking to save lives, says Duncan Watson-Parris at the University of California, San Diego. "The consequence for the climate is not great, but it's not as acute as the number of people that were dying because of air quality," he says. Previous research has suggested the measures have helped avoid 150,000 premature deaths per year.

The pace of air quality clean-up in China has slowed in recent years. "There really isn't that much air pollution left to remove from China," says Samset. That should mean warming will fall back to near the 0.18°C per decade rate recorded before 2010, he says.

But other factors could disrupt this. Just as reductions from China tapered off, in 2020 the global shipping industry implemented new rules forcing ships to curb their aerosol emissions, prompting a sharp fall in pollution over the open ocean.

This might be particularly important in changing cloud cover in those regions, says Hugh Coe at the University of Manchester, UK. "It's happening in remote places where clouds are super sensitive to change."

Scientists also warn that rising temperatures alone could be causing ocean clouds to become less reflective, reducing their cooling effect, while there are also worries that models may have misjudged how sensitive the climate system is to changes in aerosols. "The question of how fast the world will keep warming is absolutely crucial now," says Samset.

China's Ministry of Ecology and Environment didn't respond to a request for comment. ▮

Human evolution

Fossil leg deepens mystery of our tiny cousin *Paranthropus*

Colin Barras

TOM MCHUGH/SCIENCE PHOTO LIBRARY

A model of *Paranthropus robustus*, which lived up to 2.7 million years ago

A FOSSILISED left leg unearthed in South Africa belongs to one of the smallest adult hominins ever discovered – smaller even than the so-called "hobbit", *Homo floresiensis*.

The hominin was a member of the species *Paranthropus robustus*. This was one of several species of *Paranthropus*, ape-like hominins that shared the African landscape with the earliest members of our human genus, *Homo*, between about 2.7 million and 1.2 million years ago. *Paranthropus* had a heavily built skull that housed a small brain and large teeth – which some species appear to have used to chew grass like a cow.

Little is known about it because most fossils are teeth or parts of the skull. This makes the discovery of *P. robustus* leg bones an important find. "We knew immediately that we had an astonishing fossil on our hands," says Travis Pickering at the University of Wisconsin-Madison.

One thing that was instantly apparent was that the fossil – a thighbone, shinbone and part of the hip – belonged to an unusually small hominin. "It's impressive how small it is compared with the shortest of the short we've known about so far," says Richard Potts at the Smithsonian Institution in Washington DC, who wasn't involved in the analysis.

103 cm

Estimated height of the adult *Paranthropus* individual

Pickering's team estimates that the hominin, which was probably a young adult female, stood just 103 centimetres tall (*Journal of Human Evolution*, doi.org/g866mj). To put that in context, the best-preserved *H. floresiensis* individual – who lived about 80,000 years ago – was 109 cm tall.

Such a small hominin may have been an easy target for predators, says Pickering, and so *P. robustus* might have sought shelter in trees. However, there are no clear indications in the leg bones that it had adaptations for climbing. That is a surprise: a fragmentary skeleton of a related species, *Paranthropus boisei*, was discovered about a decade ago, and it did have climbing adaptations.

The two species "may have engaged in different behaviours", says Manuel Domínguez-Rodrigo at the University of Alcalá, Spain, who led the analysis of the *P. boisei* fossil. This doesn't mean that *P. robustus* couldn't climb, says Pickering, although it is unclear why it lacked the climbing adaptations seen in *P. boisei*.

Another puzzle is how *P. robustus* fed. Researchers have suggested it used bone tools to dig for tubers or insects. This implies it spent long periods of time sitting, kneeling or squatting – but there are no clear signs in the knee joint of the fossil that *P. robustus* did this. "This was a surprising finding to me," says Pickering.

It is certainly an interesting find, says Thomas Plummer at the City University of New York – but he adds that it is too early to say for sure that *P. robustus* really didn't sit or squat often. "It's a hypothesis that needs further testing."

The fossil has resolved at least one point of debate about *P. robustus*: exactly how it moved around on the ground. Although it is certain that the species could walk on two legs, it was unclear whether it did so most of the time or just occasionally. Thanks to the leg fossil, Pickering says we can now confirm *P. robustus* did walk on two legs most of the time. This, he says, is "the real revelation of our research". ▮

Astronomy

Black holes could solve space puzzle

Strange little red dots in the early universe have mystified researchers, but two studies may now have found an answer, finds **Jonathan O'Callaghan**

A MYSTERIOUS class of small, red objects in the early universe might be black holes surrounded by dense cocoons of gas, like a star.

Since launching in 2021, the James Webb Space Telescope (JWST) has found hundreds of objects in the early universe that appear extremely red and compact, dubbed little red dots (LRDs).

About a billion years after the big bang, LRDs seem to vanish. This means they might be related to a process occurring fairly early in the cosmos, and could be the progenitors of some galaxies – but their properties aren't what astronomers expected.

"We thought we knew what the earliest galaxies would be like," says Jillian Bellovary at the American Museum of Natural History in New York. "We did not think they would be like this. So we're all just coming up with the weirdest possible ideas."

Rohan Naidu at the Massachusetts Institute of Technology and his colleagues propose one such possibility. They suggest some LRDs might be supermassive black holes that are surrounded by extremely dense gas comparable to the outer regions of a star's atmosphere. The black holes would be eating this material voraciously, causing the gas to glow brightly.

"Supermassive black holes surrounded by extremely dense gas may explain odd objects spied by JWST"

Naidu and his colleagues identified an LRD in existence 660 million years after the big bang that they think fits this scenario. They declined to speak to *New Scientist* about the work while their paper is under review.

According to the team's analysis, the ball of gas around the black hole would be slightly wider than Pluto's orbit around our sun, with a mass millions of times that of our star. The black hole itself would have a hot, superheated disc of material around it, producing huge amounts of light and energy that burst through the cocoon of gas. From our point of view, that would appear as a little red dot (arXiv, doi.org/pfdx).

"I personally really like the solution," says Anthony Taylor from the University of Texas at Austin. "It's very elegant. It doesn't [require] any exotic physics, and it doesn't break the universe."

Another team, led by Vadim Rusakov at the University of Manchester, UK, who also didn't want to comment for this story, has put forward a similar explanation for LRDs in separate work (arXiv, doi.org/pfdz).

"They are all proposing this kind of embedded black hole in a very dense atmosphere," says Xihan Ji at the University of Cambridge.

There are other possible solutions. Bellovary suggests LRDs could be explained by black holes ripping apart large groups of stars at the same time. "Little red dots have a lot of similar characteristics to a black hole eating a bunch of stars," she says.

Alternatively, LRDs might be explained not by black holes, but by incredibly dense collections of stars. However, you would have to pack a huge number of stars – equivalent to 10 billion suns – into a very small space to fit the observed properties.

"You need to squeeze all this mass within 100 light years," says Ji, making a cluster so dense "you expect the stars to collide with each other". Only a few thousand stars are found within a similar distance from our sun.

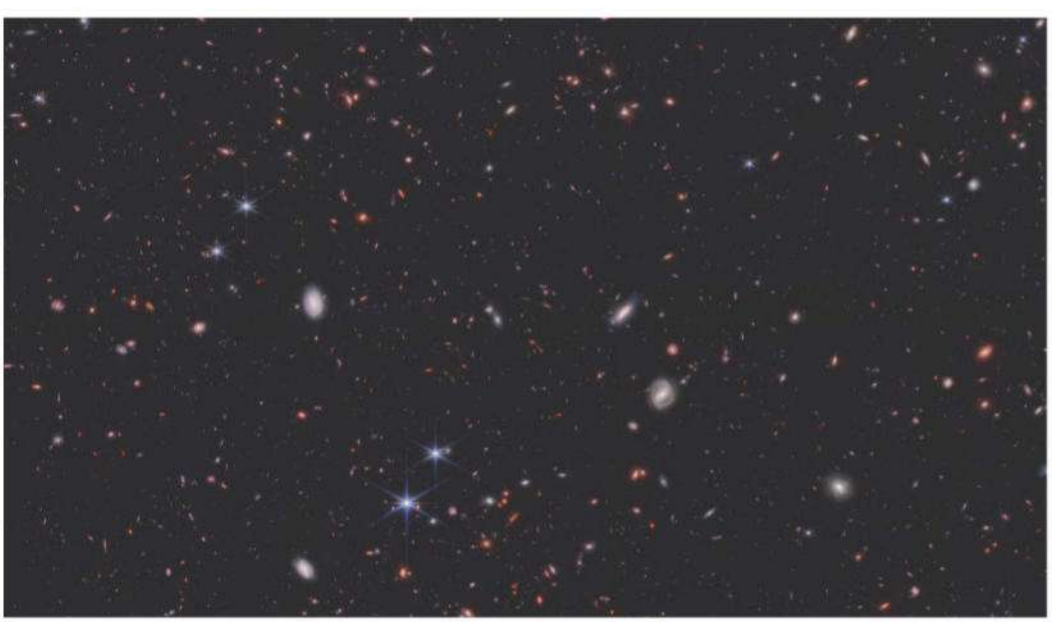
Supermassive secret

If LRDs are explained by black holes, they could reveal how supermassive black holes – the extremely dense objects found at the centre of galaxies like our own – grew in the early universe. "It could finally answer how you make a supermassive black hole," says Bellovary. "The earlier we look [in the universe], there's still supermassive black holes. At some point, they have to form. How the heck do you do that?"

Upcoming observations could help pin down an explanation. Several programmes to investigate LRDs in more detail have been selected for JWST's schedule over the next year, one of which is led by Taylor.

He will be looking for spectral lines representing absorption of light by calcium, which might point towards or against the black hole solution.

If stars are the culprit, "I'd expect to see these calcium lines", he says. "However, if we see this cocoon of gas argument, it's much less likely we would see these lines." ▮



A view of the early universe from the James Webb Space Telescope

NASA, ESA, CSA, STEVE FINKELSTEIN (UT AUSTIN)

Zoology

Monkeys use crafty techniques to get junk food from tourists

Christa Lesté-Lasserre

A GROUP of monkeys in India has developed a range of ingenious techniques to acquire food peacefully from devout tourists.

Revered as holy at the Dakshineswar temple complex near Kolkata, Hanuman langurs (*Semnopithecus entellus*) quietly grab visitors' legs, tug on their clothes, hold their hands or simply stand up in front of them, often around vendors' food stands. The wild primates usually continue such begging tactics until they get their particular treat of choice: sweet buns, says Dishari Dasgupta at the Indian Institute of Science Education and Research Kolkata.

"They have absolutely no inhibition towards humans, which is unusual," she says. "There's no sound, no aggression, no drama, no conflict. They're just gently asking for food, and the people willingly give it to them – because they think, if you feed the langurs, your sins will go away."

Dasgupta and her colleagues observed 31 langurs, mostly adult females, in Dakshineswar on multiple occasions. They noted 1293 begging events, 81 per cent of which resulted in the monkeys getting food. The animals were most likely to get food if they grabbed people's legs or, to a slightly lesser extent, if they tugged on clothing (*Animal Cognition*, doi.org/pd43). Such successes might be due, in part, to the fact that people had a hard time getting away from the monkeys otherwise, says Dasgupta.

DISHARI DASGUPTA

Langurs hold people's hands (left) or grab clothing (right) for food

Simply standing next to another begging langur also yielded high rates of food offerings, she says.

Even so, the langurs were rarely satisfied with carrots, cauliflower and other healthy foods. The monkeys mostly ignored these offerings and kept begging until they got their favourite processed foods, packaged sweet buns and roasted peanuts. "This is not something they are supposed to be eating in the first place, in their natural habitats," says Dasgupta.

It isn't really surprising that the monkeys figured out how to beg, especially since the practice reaps such great rewards, says Elizabeth Warren at Johns Hopkins University in Maryland. The behaviour is a classic case of what is known as operant conditioning, learning that certain actions lead to certain benefits, such as food.

"It seems to be something that the monkeys happened upon somehow, and which worked," she says. "When it started, resulting in something they wanted, they had this goal of, 'I want food', and they repeated it."

The langurs never stole food from vendors' carts, but rather opted for peaceful begging. They might have learned that stealing doesn't work after getting chased away by vendors, says Josep Call at the University of St Andrews, UK. "So, when they find out what does work – begging – they do it multiple times," he says. "Eventually, it becomes ritualised." ▮

Evolution

The surprising origin of the anus in animals

THE anus is a wildly successful innovation, but how did it evolve? A genetic analysis suggests it began as an opening to release sperm that later fused with the gut. "Once a hole is there, you can use it for other things," says Andreas Hejnol at the University of Bergen in Norway.

It is thought that early animals evolved the mouth and gut before the anus, as some simple creatures such as jellyfish still have this body plan. They have to expel their waste out of their mouth, says Hejnol.

One idea for how early animals evolved an anus is that their mouths split in two. However, in 2008, Hejnol showed that the key genes controlling the development of the mouth region are quite different to those for the hindgut, suggesting an independent origin for the anus.

Hejnol and his team studied animals such as *Xenoturbella bocki*, a worm-like organism found on the seabed with a mouth and gut, but no anus. It may be a living representative of an ancient group that was intermediate between the ancestors of jellyfish and the first animals with an anus.

They have found that *X. bocki* has a separate opening for releasing sperm called a male gonopore. There is no female opening, as eggs are released via the mouth. The team also found that several of the key genes controlling the development of the hindgut in animals with an anus also control the development of the gonopore in animals such as *X. bocki*, suggesting an evolutionary link (bioRxiv, doi.org/pd4x).

"It is likely that the hole existed, and the digestive system was close by. And then they just fused"

"What happened is likely that the hole [gonopore] existed, and the digestive system was close by," he says. "And then they just fused. They made a common opening."

"The data are beautiful and very convincing," says Max Telford at University College London. "I've worked on *Xenoturbella* for a long time, and the fact that we've never noticed it having a gonopore is extraordinary."

However, he thinks the group of animals to which *X. bocki* belongs once had an anus with a connected gonopore, then lost the anus. In other words, this group appeared only after the evolution of the anus. Hejnol thinks his own interpretation is more likely, but for now there is no way to end the debate. ▮

Michael Le Page

Quantum physics

On the edge of the quantum realm

What lies beyond quantum mechanics? We now have mathematical tools to help us look

Karmela Padavic-Callaghan

QUANTUM entanglement can link two objects even when they are separated by extremely large distances. But a new study has found a limit at which such quantum correlations stop – and, surprisingly, something even stronger may begin. "Honestly, we are at the edge of science here," says Jean-Daniel Bancal at Paris-Saclay University in France.

To verify that two quantum objects are entangled, physicists use what are called Bell tests: they repeatedly measure the system to determine all of its possible states, then create a "probability distribution" to show how likely the system is to be in any one state.

Bancal and Victor Barizien, also at Paris-Saclay University, have now calculated exactly which probability distributions are allowed by quantum theory, and suggest that any quantum objects that don't match actually belong to some more exotic, post-quantum theory.

Normally, physicists would calculate a probability distribution based on the physical details of an object, but the pair devised a way to invert this method. Instead, they started with the many possible probability distributions and determined which could be matched to their physical quantum system (*Nature Physics*, doi.org/g89w7s). "This is a great technical achievement," says Valerio Scarani at the National University of Singapore.

Ivan Šupić at University Grenoble-Alpes in France says that fully characterising the set of all possible quantum correlations becomes exceedingly difficult as objects become more complex – because there are more potential states for the system. That means that while it is fairly easy to see where classical correlations end and quantum ones begin, it is more problematic to work out when something quantum crosses into something that is possibly post-quantum.

Martin Plesch at the Slovak Academy of Sciences says the work may also offer mathematical tools for making quantum communication and computing protocols more secure, allowing researchers to measure the properties of a quantum device and determine how they are correlated, instead of having to know the details of its hardware – something that is impossible for traditional computing devices.

"It is hard to work out when something quantum crosses into something possibly post-quantum"

"We don't have to trust the manufacturer of the device. We can just test the device on 'What is it doing?' And results like this make the tests more rigorous," says Plesch.

But there may also be consequences for how we think about quantum theory, says Scarani. Some probability distributions that lie beyond the post-quantum border break laws of physics that would make them impossible to find in nature. But others don't. This leads to a big question: is our world entirely inside the quantum border – or not?

The question remains tantalisingly open, especially since there aren't any rigorous and agreed-upon post-quantum theories, but this new work could help point the way, says Barizien.

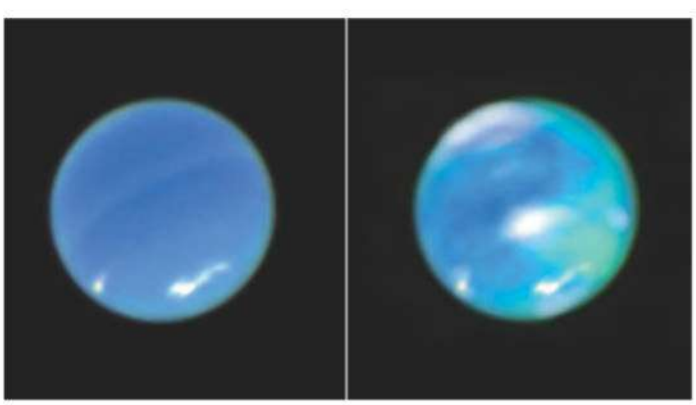
Solar system

Auroras seen on Neptune for the first time

INFRARED auroras have been spotted swirling in Neptune's atmosphere, verifying decades of scientific speculation.

When NASA's Voyager 2 mission flew by Neptune in 1989, it found intriguing hints of aurora activity in the ice giant's clouds. However, scientists were unable to verify the phenomenon at the time, as existing instruments were too weak. Now, the James Webb Space Telescope (JWST) has finally provided the power to detect them.

"This was really a fulfilment of years' worth of anticipation," says Heidi Hammel at the Association of Universities for Research in Astronomy in Washington DC.



NASA, ESA, CSA, STScI

Green blotches in the right hand image show the auroras lighting up Neptune's sky

Hammel and her colleagues used JWST's NIRSpec, a powerful infrared imaging tool, to analyse the different wavelengths of light emitted by the planet. In 2023, JWST detected infrared auroras on Uranus. This time, it found them on Neptune as well (*Nature Astronomy*, doi.org/pd4q).

The images also allowed Hammel and her team to begin constructing a map of Neptune's magnetic field. This is particularly exciting, as the planet is known to have some of the most unusual magnetic poles in the solar system.

Unlike Earth, Jupiter or Saturn, Neptune's magnetic poles aren't centred at its rotational poles. Instead, "they're offset by almost half the planet's radius", says Hammel. As a result, its auroras appear as irregular blobs much closer to its equator.

In addition to detecting auroras, the JWST observations indicate that Neptune's ionosphere – the layer of charged particles blanketing some planets – is cooling down. It is now, on average, about 10 per cent colder than when Voyager 2 passed by nearly 36 years ago. While the authors of the new study aren't sure why this cooling occurred, they hope their next JWST observation period, scheduled for 2026, will offer more clues.

Joanna Thompson

Does aspirin have potential as an anti-cancer drug?

Research into whether aspirin could help prevent certain types of cancer is ongoing, with mixed results, finds **Fiona MacRae**

IMAGINE if a cheap, accessible and relatively safe pill could prevent cancer in those who have never had it and stop it from returning in those in remission. The idea that aspirin is such a "wonder drug" is the subject of intense research, but the picture is muddled.

The notion that aspirin could have anti-cancer properties dates back decades. In 1988, researchers in Australia linked the painkiller to a lower risk of colorectal, or bowel, cancer. More than 100 of these observational studies have since tried to untangle the relationship between aspirin and different types of cancer.

Much of this focus has been on colorectal cancer. In fact, daily aspirin is recommended by the National Institute for Health and Care Excellence (NICE), a UK medical guidelines body, for people with Lynch syndrome, a genetic condition that increases colorectal cancer risk. Aspirin may be effective because it suppresses or destroys lesions in the gut that could turn cancerous.

PIXELSEFFECT/GETTY IMAGES

Aspirin may work as more than a painkiller for some people

Mixed messages

But for people without Lynch syndrome, the situation is much less clear-cut. While some studies suggest aspirin reduces the risk of colorectal cancer, a recent paper found that it was no better than a placebo at helping people who had already been treated for colorectal cancer to live longer after completing treatment.

A 2018 study even linked daily aspirin to a higher rate of cancer-related deaths among older people. This was particularly true for gastrointestinal cancers, including colorectal ones.

But Andrew Chan at Harvard University wasn't convinced that this trial, called ASPREE, provided all the answers on aspirin's cancer-protecting potential. "ASPREE was a very narrow population," he says. "Participants were over the age of 70 years old and the follow-up was short, less than five years."

So Chan decided to investigate further. Focusing on colorectal cancer, he and his team looked at 30 years of data on more than 100,000 people in the US, who self-reported whether they regularly took aspirin. The results suggest that at least two tablets a week could prevent colorectal cancer – but mainly among those with the unhealthiest lifestyles. Those with healthier habits, such as eating well and not smoking, seemed to benefit to a much lesser extent.

Off the back of these findings, Chan says the key is to personalise aspirin prescription guidance for people who stand to benefit the most, for instance, those who don't follow advice to reduce their colorectal cancer risk, such as by exercising regularly.

"I am hopeful that, in the future, we will be able to define better the subsets of the population that are more likely to benefit from aspirin and the subgroups who have any potential harms," he says.

Chan has no plans to test this in a randomised controlled trial, which would help determine whether aspirin's side effects, such as stomach ulcers and bleeding, would be tolerable for such use.

"It's very clear the risk of bleeds and fatality associated with the bleeding rises rapidly from [age] 70 onwards," says Mangesh Thorat at Queen Mary University of London. He wonders if it might be best to consider aspirin's use for this purpose starting from about age 50, for five to 10 years.

> **"The jury is still out on whether aspirin can reduce the spread of cancer in people"**

Complicating matters further, aspirin's effects seem to vary by cancer type. For example, a study of more than 1 million people over 20 years suggests that long-term aspirin use may decrease the risk of colon, rectum and stomach cancers, but raise the odds for lung and bladder cancers. Meanwhile, a study from April 2024 found that among people in remission for breast cancer, daily aspirin didn't prevent recurrence or survival over a placebo.

Yet recent research supports Chan's stance that personalisation may be key. Anna Martling at the Karolinska Institute in Sweden and her colleagues found that colorectal cancer is about half as likely to recur if aspirin is given to people with specific genetic mutations after they have surgery to treat the condition. "This is quite a stunning benefit from what is just a cheap, easily available drug," says Han Chong Toh at the National Cancer Centre Singapore. "Certainly, larger studies will need to further confirm this encouraging result."

These mutations are in around 15 to 20 per cent of colorectal cancers and involve a signalling pathway, called PI3K, that may promote colorectal cancer initiation, progression, spread and drug resistance – a pathway that aspirin may block.

A recent study in mice also suggests that it may be worth not throwing in the towel quite yet. Scientists at the University of Cambridge found that aspirin reduces the production of a lipid called thromboxane A_2, which hampers the ability of immune cells called T-cells to recognise and kill cancer cells that are spreading in the body, supporting the idea the drug has protective potential.

"I think what all this shows is that the jury is still out on whether aspirin can reduce the spread of cancer in people," says team member Rahul Roychoudhuri. In the future, we could focus our attention on figuring out who may benefit most, he says. ▮

Speak to your physician before changing any medication

Zoology

Big spots may help giraffes keep warm

Chris Simms

ANDREY GUDKOV/BIOSPHOTO/ALAMY

THE patterns on a giraffe's coat work as more than camouflage – the size of the spots seems to be connected to how well they survive in cooler or warmer conditions.

A baby giraffe's spots help it blend into the dappled light near bushes. But because the spots are darker than the rest of the fur, it is also thought they might affect how the animals handle temperature.

To investigate, Alexia Mouchet at the University of Zurich in Switzerland and her team studied 810 wild Masai giraffes (*Giraffa camelopardalis tippelskirchi*) inhabiting the Tarangire ecosystem in Tanzania.

Because the spot patterns are unique, the researchers could identify which individuals they saw in three surveys each year from 2012 to 2020. Overall, they found that calves with small, lobed spots and adult males with small, lobed or large, polygonal spots were more likely to survive.

Yet, when average seasonal temperatures got to a degree or two above or below the seasonal mean, the picture changed.

Survival of adult male and female giraffes was lower at these times. However, the calves and adult males with larger spots were more likely to survive when the temperature was anomalously low, and those with smaller spots had higher survival chances when the temperature was very high (EcoEvoRxiv, doi.org/pd3m).

The size of a giraffe's spots is linked to survival in unusual temperatures

Spots do help camouflage young giraffes, says team member Monica Bond, also at the University of Zurich. But adults are less likely to fall prey to animals like lions, she says. Any advantage from the markings later in life may be down to how they help the giraffes adjust body temperature.

The spots have an underlying dense network of blood vessels, says Bond, and it is thought they can constrict them to conserve heat when it is cold or expand them to release heat when it is hot. That might explain why bigger spots are leading to better giraffe survival when it is colder.

However, the spots may also absorb more of the sun's heat than lighter fur, so when temperatures get too high, the giraffes may overheat, says Mouchet. ▮

Technology

Quantum computers are on track to solve knotty problems

Matthew Sparkes

QUANTUM computers could soon be able to solve genuinely useful mathematical problems faster than classical computers, claims quantum computing firm Quantinuum. It would be the first example of these machines showing a true advantage over ordinary devices.

Such problems relate to a branch of mathematics called knot theory, which is used to classify knots by the number and nature of the points at which they cross over. The concept has been applied to cryptography, physics and molecular biology. It has even been suggested as a way for spacecraft to navigate and as the basis for a new type of quantum money.

The calculations involved grow extremely difficult for classical computers as the crossover number increases,

"This could be the first example of quantum computers showing an advantage"

but now Konstantinos Meichanetzidis at Quantinuum and his colleagues have developed a quantum algorithm to do the job. What's more, they have also created a model that calculates how long the algorithm will take to solve a problem, based on both its size and the error rate and power of the quantum computer running the algorithm.

Using this model, the researchers have determined exactly where the threshold of quantum advantage lies for knot theory problems. For Quantinuum's Apollo computer, due for release in 2029, this point arrives at knot problems with just 2800 crossings (arXiv, doi.org/pd3r).

Previous claims of quantum advantage have involved solving largely useless problems, but Aleks Kissinger at the University of Oxford says Quantinuum's work suggests quantum computers could soon demonstrate genuine usefulness.

"If they run this on the next [Quantinuum] model and they can really outpace supercomputers, I would say that is going to be one of the first instances of quantum advantage for a problem that they didn't just invent for the sake of running on quantum computers, you know? This is a pre-existing problem that people care about," says Kissinger. "It gives me some confidence that we will see these kinds of interesting proofs of advantage within a year or two."

Another issue with previous claims, like Google's first declaration of quantum supremacy in 2019, is that they are often later overturned by improved classical algorithms. Meichanetzidis says that he is keen to avoid such a scenario, and in fact, his team worked to improve the state-of-the-art classical algorithms for knot problems ahead of publication, to ensure that their model was as robust as possible.

"If we are brave enough to say that we are quantifying where advantage happens, where it kicks in, we have to be very stringent," says Meichanetzidis. "Quantifying quantum advantage should be done as rigorously, at least as rigorously, as we do it [at Quantinuum]. I think the quantum community should increase their standards for when they should say such words such as advantage." ▮

Climate change

Microalgae could offset emissions

Increased photosynthesis could counteract carbon released from peatland as world warms

Madeleine Cuff

MICROBES in carbon-rich soils ramp up their rate of photosynthesis in warmer conditions, suggesting climate models may be overestimating the total emissions expected from degrading landscapes as the climate warms.

Ecosystems like peatlands and permafrost are expected to start rapidly releasing stored carbon dioxide due to microbial activity in their soils shifting as the world warms. This could be a huge source of future emissions, with estimates suggesting the northern hemisphere stores 1.5 billion tonnes of carbon in permafrost, while the world's peatlands store around 600 billion tonnes.

But the picture might not be so bleak. Climate models assume that as the world warms, soil microbes that break down organic matter will do so more quickly, increasing the rate of CO_2 emissions. Yet the same conditions might trigger other microbes found in soil, such as microalgae, to increase their rate of photosynthesis. This would result in a drawdown of more carbon from the atmosphere, partially mitigating the impact of the CO_2 being released.

Scientists are just starting to quantify the climate benefit of this effect. As part of this, Vincent Jassey at the Center for Research on Biodiversity and Environment in France and his colleagues set out to measure the impact of photosynthesising microbes on the uptake of carbon in peatlands.

They transplanted 125 blocks of peat from five sites in Europe to expose the samples to new environmental conditions, and monitored the resulting microbial activity. The team found that warmer conditions triggered enhanced photosynthesis activity among microbes. "It's a very strong response and it is similar across all the communities that we tested," says Jassey.

The team used these results to build the first model that quantifies how much photosynthesising microbes could offset emissions from peat bogs on a global scale. They estimate it could amount to the drawdown of more than 51 million tonnes of carbon per year between 2021 and 2040, equivalent to about 14 per cent of the projected rise in peatland emissions over the same time frame (*Nature Climate Change*, doi.org/pdws). "I was really surprised to see how much carbon it could offset," says Jassey.

Jean-Philippe Gibert at Duke University, North Carolina, says a similar effect has been observed in peatlands in Minnesota and Alaska. "I've seen enough – I'm convinced this is happening," he says. "There is real possibility for this mitigation in one of the most important carbon sinks in terrestrial ecosystems on the planet." The largest effect would probably be reserved for boreal and temperate peatlands, which are set to experience bigger swings in temperature, he adds.

The effect may not be limited to peatlands. "Microalgae are everywhere in soils. So these mechanisms could happen in every type of ecosystem," says Jassey. ▮

Peat bogs, like this one in Scotland, may not release as much CO_2 as feared

MARK HAMBLIN/NPL/ALAMY

Chemistry

Wood made see-through using rice and egg whites

WINDOWS and smartphone screens may one day be constructed from transparent wood laced with egg whites and safely composted at the end of their life.

Wood has been turned into a transparent material before by removing the organic polymer lignin from it and then injecting epoxy as a replacement, but this results in a non-biodegradable product. Now, Bharat Baruah at Kennesaw State University in Georgia and his team have developed a process that replaces the synthetic epoxy with natural egg white and rice extract.

"[Previous examples of transparent wood are] very hard to synthesise, hard to make and you spend a lot of time and energy and money to make those," says Baruah.

He was inspired to use egg whites by buildings in his home state of Assam in India, which date back to the 1500s and used a cement-like mixture that included sand, sticky rice and egg whites. "That was the cement in those days, and those buildings are still there," says Baruah. "They're still there after more than four or five centuries."

The team took sheets of balsa and drenched them with sodium sulphite, sodium hydroxide and diluted bleach in a vacuum chamber to remove the wood's lignin and hemicellulose, leaving a paper-like cellulose structure. The voids in the material were then filled with rice extract and egg white before being dried in an oven at 60°C (140°F) to create a semi-transparent plate with a slight brown tint. "It's not 100 per cent transparent, but it is semi-transparent," says Baruah. "And it's biodegradable."

"It's not 100 per cent transparent, but it is semi-transparent. And it's biodegradable"

Baruah and his colleagues built a small birdhouse fitted with a transparent wood window as a mock-up, and found that it stayed 5 to 6°C (9 to 11°F) cooler inside when exposed to a heat lamp than the same birdhouse fitted with a glass window. The research was presented last week at the spring meeting of the American Chemical Society in San Diego, California. ▮

MS

Cosmology

An early hint of cosmic dawn has been seen in a distant galaxy

Jonathan O'Callaghan

A GALAXY found at the dawn of the universe appears to be the earliest known evidence of cosmic reionisation, the period when the universe was lit up for the first time.

Following the big bang, the early universe was filled with hot hydrogen and helium gas that scattered photons, making the cosmos somewhat opaque. Over the next few hundred million years, as stars began to shine, their light ionised the hydrogen and helium, enabling photons to flow freely and making the universe transparent, though the exact timing of this is uncertain.

Joris Witstok at the University of Copenhagen in Denmark and his colleagues used the James Webb Space Telescope (JWST) to study a galaxy called JADES-GS-z13-1-LA. The galaxy is seen 330 million years after the big bang, making it one of the earliest known galaxies in the universe.

Ultraviolet light from the galaxy suggests it was surrounded by a bubble about 200,000 light years across, which might be the result of its starlight interacting with the surrounding cosmic hydrogen (*Nature*, doi.org/g89w79). Seeing evidence for this so early in the universe is "beyond even our wildest expectations," says Witstok.

Michele Trenti at the University of Melbourne agrees that the observations are consistent with the process of cosmic reionisation. "It is both surprising and exciting," says Trenti. "I would not expect the ultraviolet light emitted from this galaxy to reach JWST. The cold, neutral hydrogen gas that we were expecting would have surrounded the galaxy should have blocked the photons. We are witnessing the onset of reionisation."

"This would be the earliest known evidence for a supermassive black hole at the centre of a galaxy"

ESO/M. KORNMESSER

An artist's impression of the distant galaxy JADES-GS-z13-1-LA

The nature of the small galaxy itself is not entirely clear; it might be shining brightly because of a population of massive, hot, young stars, or a powerful central black hole. "This would be the earliest known evidence for a supermassive black hole at the centre of a galaxy," says Trenti.

While astronomers have seen other, later galaxies with a similar bubble around them, JADES-GS-z13-1-LA is the earliest known example.

"It's a benchmark," says Richard Ellis at University College London. "It tells us that this galaxy must have been around for quite a while, and pushes that little bit further back to the beginning of when galaxies first emerged from darkness."

JWST was able to unearth the secrets of this galaxy only by staring at it for a relatively long time, about 19 hours. Witstok is hopeful we might soon see other early evidence for cosmic reionisation. "We have a few more candidates," he says. "We might find it even further [back in time], or maybe this is the most extreme that it gets." ▮

Palaeontology

Extraordinary wasp may have used its rear end to trap flies

AN EXTINCT ancient wasp found preserved in amber may have used its abdomen to grasp other insects like a Venus flytrap before laying its eggs on them.

"It's unlike anything I've ever seen before. It's unlike any wasp or any other insect that is known today," says Lars Vilhelmsen at the Natural History Museum of Denmark.

Vilhelmsen and his colleagues named the wasp *Sirenobethylus charybdis* after Charybdis, a sea monster in *The Odyssey* by Homer. The insect lived almost 99 million years ago in the Cretaceous Period.

The researchers used micro-CT scanning to examine 16 female wasps that were encased in amber found in the Kachin region of Myanmar. All had three flaps in their abdomens, making up a clasping structure. Sometimes it was preserved open and sometimes partly closed, suggesting it was a movable, grasping device (*BMC Biology*, doi.org/g89xbd).

QIONG WU

This wasp had an unusual appendage (right of image) reminiscent of a Venus flytrap

"It was very exciting, but it was also a challenge, because how can you explain how this animal worked when you have nothing like it today?" says Vilhelmsen.

He and his colleagues compared it with living and extinct wasps. This revealed that the closest analogues are modern-day parasitoid species of the superfamily Chrysidoidea. These include cuckoo wasps, the larvae of which live on their hosts as parasites.

The key to the behaviour of *S. charybdis* may be the lower flap of the trap-like abdomen, which could have acted like a Venus flytrap plant, says Vilhelmsen. He suggests that the wasp would have waited in ambush for flying insects with its trap open and then snapped it shut to restrain the host and lay its eggs.

"What I find extraordinary is [this] is a brand new solution to a problem that all parasitoid insects have: how do you get your host to stop moving while you lay your eggs on or in it?" says Manuel Brazidec at the University of Rennes in France. ▮

Chris Simms

Pregnancy's lasting effects

Bodily changes that occur during pregnancy can take months or possibly even years to be reverted, finds **Carissa Wong**

AS ANYONE who experiences it knows, pregnancy vastly transforms the body – and now we have the most detailed picture yet of how it affects the blood, organs and immune system on a weekly basis. This could help provide treatments post-pregnancy, as well as reveal the risks of developing certain conditions while pregnant.

"We got an unprecedented view of the way the mother's body is changing week by week, to compensate for the incredible load on it, and how long it takes to recover after delivery," says Uri Alon at the Weizmann Institute of Science in Rehovot, Israel.

DANIEL BEREHULAK/GETTY IMAGES

The way the body changes after birth is understudied

Despite its importance, pregnancy has been understudied, says Alon. For example, previous research has tracked how around 20 blood markers, such as salt and iron levels, change in dozens of women during pregnancy up to roughly six weeks after delivery, using samples taken during standard healthcare.

"These experiments are usually done on a small number of patients, and they sample just once every trimester or one time point after delivery," says Alon.

Mapping the body

To get a more comprehensive view, Alon and his colleagues analysed blood samples previously collected from more than 160,000 women in Israel, aged between 25 and 31, who collectively had over 300,000 pregnancies. Together, these samples provided a snapshot of the body each week from 20 weeks before conception to 18 months after delivery, with each woman providing data for a few points in time.

This approach gives useful insights into how the body generally changes during pregnancy at a population level, though tracking the same women at every time point would provide a better picture of individual trajectories, says Christoph Lees at Imperial College London.

The researchers mapped out changes in 76 blood markers, such as the levels of proteins, fats and salts, that indicate the function of the liver, kidneys, blood, muscles, bones and immune system. They found that each of these markers varied widely from pre-conception levels during pregnancy, before either gradually returning to pre-pregnancy levels or overshooting the other way before settling back to the pre-pregnancy baseline.

Notably, the scientists found that while 36 of the markers, including those related to blood clotting, bounced back within a month after delivery, 31 markers took over 10 weeks to recover (*Science Advances*, doi.org/pdvs). For instance, some changes to the liver and immune system took around five months to return to pre-pregnancy levels, and several kidney markers took roughly half a year. Some bone and muscle markers took even longer. What exactly this means for women's health is unclear, but it should be explored in future work, says Alon.

What's more, a few other markers never returned to baseline levels, even over a year after birth. "The slightly old-fashioned view that by six or eight weeks after pregnancy, everyone's completely back to normal, is clearly wrong," says Lees.

"The view that by six or eight weeks after pregnancy everyone's back to normal is clearly wrong"

For instance, iron levels remained low long after giving birth. "Women are quite likely to be anaemic [have low iron levels] after delivery because of haemorrhaging, and because a developing fetus takes a lot of the iron stores out of their bodies," says Lees. "We typically think it takes six to 12 months for iron stores to get back to normal – this suggests it might take even longer."

Meanwhile, levels of a protein called CRP stayed high. "CRP is affected by a number of different processes. Certainly inflammation is one of them, but things like hormonal changes can also affect this," says Lees.

Pre-eclampsia risk

In another analysis, the team looked at markers in women who had pre-eclampsia – a condition during pregnancy where high blood pressure can cause headaches, vision problems and pre-term birth, and lead to fatal complications for both mother and baby if left untreated. This revealed that, before conception, women who developed pre-eclampsia had elevated levels of blood cell fragments called platelets and a protein called ALT, compared with those who didn't develop the condition.

"For decades, the idea has been that the placenta doesn't implant properly, and if it doesn't implant properly, the blood supply is disrupted, it releases hormones and substances that lead to the mother getting high blood pressure," says Lees. "But some studies suggest that those who develop it have a different cardiovascular function before pregnancy – these findings add weight to this theory."

If further studies show that these pre-conception markers do indicate the risk of pre-eclampsia, they could potentially be used to pinpoint women at high risk. "Then you could target them with ways of improving health prior to pregnancy – either through exercise and lifestyle advice – to lower their risk," says Lees. ▮

Health

Fake pills ease PMS even if you know they are placebos

Carissa Wong

WOMEN with premenstrual syndrome (PMS) seem to benefit from the placebo effect even when they know they are taking sham pills, suggesting this could provide a treatment.

PMS involves symptoms such as anxiety, mood swings and cramps. Previous studies have found that placebo pills can reduce symptoms in women who think they may be taking a real medication, but it was unclear whether these benefits remain when people knowingly take sham pills.

Antje Frey Nascimento at the University of Basel in Switzerland and her colleagues recruited 150 women in Switzerland who had moderate to severe PMS. In a survey that scored 27 PMS symptoms on a scale of 0 to 5, the participants rated at least one symptom a 4 or a 5 at the start of the study.

Next, the researchers randomly assigned one-third of participants to take two placebo pills daily over two menstrual cycles, and told them they were taking placebos. Another third of the participants also knowingly took placebo pills, but they received an explanation of how placebos can relieve symptoms through the power of suggestion and belief. The remaining third weren't given placebos. Everyone completed daily surveys on their PMS symptoms.

The team found that those who took placebos with no explanation saw a 50 per cent reduction, on average, in the intensity of their PMS symptoms, compared with what they reported before they took the pills. Those who took a placebo with an explanation reported an even greater reduction of 79 per cent in the intensity of their symptoms (*BMJ Evidence-Based Medicine*, doi.org/pdvj).

"That is a really substantial effect that you will notice in your life," says Stefan Schmidt at the University of Freiburg in Germany. ▮

Climate change

Even moderate CO_2 emissions could lead to 7°C of warming

Michael Le Page

NOAH BERGER/ASSOCIATED PRESS/ALAMY

Wildfires, like this one in California, are more likely in a warmer world

EVEN with moderate emissions of greenhouse gases, a scenario currently expected to warm the planet by about 3°C, there is a 1-in-10 chance of reaching 7°C of warming by 2200.

"Three degrees is already very bad, of course," says Andrey Ganopolski at the Potsdam Institute for Climate Impact Research in Germany. "Seven is not twice as bad as 3, or even three times as bad. It's probably 10 times worse, because many things are non-linear."

The model developed by Ganopolski and his colleagues also shows that even if all CO_2 emissions stopped this century, there is around a 1-in-10 chance that Earth could still warm by more than 3°C.

How much hotter the planet gets depends partly on how much CO_2 and other greenhouse gases we pump into the atmosphere, and partly on how sensitive the climate is to increases in greenhouse gases.

The amount of warming that would occur in the long run after a doubling of CO_2 levels in the atmosphere is called the equilibrium climate sensitivity. It depends on various fast feedback effects that occur when temperatures rise, such as increases in water vapour in the atmosphere. Studies suggest that the equilibrium climate sensitivity could be anywhere from 2°C to 5°C, but for models run beyond 2100 it has been assumed to be 3°C.

"Seven degrees is not twice as bad as 3. It's probably 10 times worse, as many things are non-linear"

The researchers instead tweaked their model to explore what the impact would be if the equilibrium climate sensitivity differs from this expectation.

Their model also includes additional and longer-term carbon feedback effects such as the release of CO_2 and methane from permafrost and wetlands. Previous models looking beyond 2100 haven't included both CO_2 and methane feedbacks, says Ganopolski.

Including both can have a big impact, he says, because higher CO_2 leads to more methane being released and vice versa.

For an equilibrium sensitivity of 3°C, the team's results are similar to those of other studies, leading to warming of around 3°C just after 2200 for a moderate-emissions scenario. For higher sensitivities, the model projects warming of up to 7°C (*Environmental Research Letters*, doi.org/g89pkq).

While the 23rd century might seem a long way off, it's not that far away in terms of human generations, says Ganopolski. "I have grandchildren who will likely live in the next century."

The reason there is so much uncertainty about the equilibrium climate sensitivity is that aerosol emissions, such as pollution from ships, have been counteracting the warming effect of greenhouse gases, says Ganopolski. A cut in shipping emissions is thought to have contributed to the recent rapid warming, for instance. The effects of aerosols are extremely complex, making it hard to quantify their cooling impact. "At the present, we cannot rule out high climate sensitivities," he says.

"An emission pathway that we think will get to, say, 2°C in 2100 could be much higher or much lower depending on these fundamental uncertainties," says Andy Wiltshire at the Met Office, the UK's weather service.

If equilibrium climate sensitivity is on the low side and future emissions are limited, warming of 3°C can still be avoided, says Ganopolski – but he thinks it is already too late to limit warming to under 2°C. ▮

Mental health

Smartphones show benefits for kids

Phone use may boost well-being and social connections in children – if they avoid social media

Chris Stokel-Walker

A SURVEY of more than 1500 children suggests smartphones can be beneficial to their mental and social well-being – unless they start using social media.

Justin Martin at the University of South Florida surveyed 1510 kids between the ages of 11 and 13 in the state as the start of the 25-year nationwide Life in Media Survey, which will explore the link between digital media and well-being.

The researchers found that 78 per cent of the children surveyed owned a smartphone. Of these, 21 per cent reported symptoms of depression and anxiety, compared with 26 per cent of those without a device. The children with phones were also more likely to report spending more time in person with friends.

"We thought that smartphone ownership would be associated with negative outcomes or negative measures," says Martin. "But that wasn't the case."

The highest prevalence of smartphone ownership, at 87 per cent, was found in children living in households earning between $50,000 and $90,000, while just 67 per cent of children in households earning $150,000 or more owned a smartphone.

Martin suggests this could have been in response to richer parents being more aware of negative headlines around the supposed risk of social media affecting mental health, while also reflecting the policies of the schools their kids attended: 58 per cent of private schools had a total ban on phones, compared with 43 per cent of public schools.

But such bans may be on shaky scientific ground, says Martin. "We were careful to highlight associations rather than causation, but kids who have smartphones probably use them for social purposes, and in the same way that many adults do," he says.

However, the researchers also found that children who said they often posted on social media were twice as likely to report sleep issues and symptoms of depression or anxiety, compared with those who never use these platforms. That said, the survey wasn't able to identify if increased social media use led to mental health and sleep issues, or if the reverse is true, says Martin.

"Kids with smartphones probably use them for social purposes, and in the same way many adults do"

"We recommend that parents and adults consider trying to keep their kids from social platforms where they would post frequently – or try to keep them from posting on social platforms," says Martin. "But of course, it's hard to tell a kid: 'You can use Instagram, you can use TikTok, but just don't post'."

The children surveyed were evenly divided themselves about the merits of social media, with 34 per cent agreeing that it causes more harm than good, 33 per cent disagreeing and the rest undecided on the issue.

"This is a fascinating study that makes important distinctions, particularly between smartphones and social media," says Jess Maddox at the University of Alabama. "While the two have become synonymous with one another, this research shows that they are not, in fact, the same."

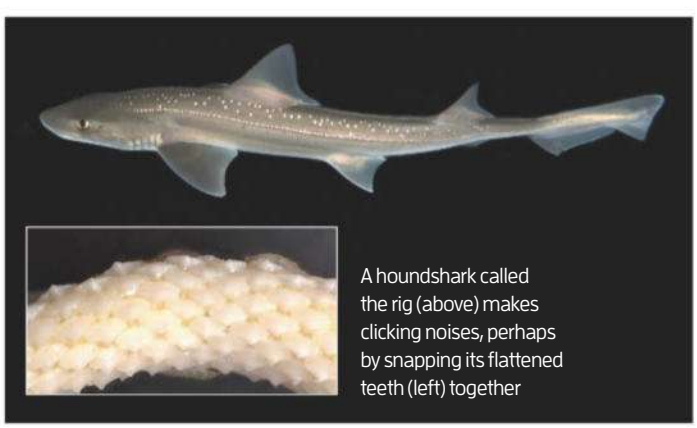
"These are really nuanced findings that I hope encourage parents, educators, and politicians to think more of education for children on smartphones and social media, not bans," she says. ▮

Marine biology

Strange clicking shows sharks aren't silent after all

AT LEAST one shark species has a bark to go along with its bite. It can make clicking noises, a first among an animal group once thought to be totally silent.

During her doctoral research at the University of Auckland in New Zealand, Carolin Nieder, now at Woods Hole Oceanographic Institution in Massachusetts, was studying sharks' hearing. When handling the sharks, she noticed one species – a houndshark called the rig (*Mustelus lenticulatus*) – appeared to make metallic clicking sounds. "I was just kind of ignoring it because sharks are not supposed to make sounds," says Nieder.



PAUL CAIGER, ERIC PARMENTIER

A houndshark called the rig (above) makes clicking noises, perhaps by snapping its flattened teeth (left) together

"And it just kept happening."

While many fish emit sounds by scraping objects or vibrating their muscles, no shark sounds had been formally described.

To confirm the rig's noisiness, Nieder and her colleagues brought 10 juvenile rigs caught off New Zealand's North Island into the lab and placed them in tanks with sound-recording instruments. The team gently handled the sharks and found that all of them made a clicking noise in response. The rig appears to be the first shark known to produce sounds that aren't associated with other actions, such as feeding or bumping into something (*Royal Society Open Science*, doi.org/pdt9).

The researchers think the sharks may be producing the sounds by snapping their jaws together. The rig has flattened teeth, which might create a sharp sound upon impact.

Nieder points out that the rig is a small shark and potential prey for larger animals, so it is possible the clicking has a role in defence when the animal is bitten or grasped.

"It could be to disorient the predator a little bit," she says. It is also possible the clicking has a role in hunting, she adds, such as scaring or discombobulating the sharks' crustacean prey. ▮

Jake Buehler

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Comment

A wing and a prayer

Would you want an AI flying your holiday jet? A cost-cutting plan may give you no choice. But it's a risk too far, argues **Paul Marks**

A DANGEROUS idea is stalking the world of passenger aviation: that of halving, sometime in the 2030s, the number of pilots at the helm of civilian airliners and filling the vacant seats with AI – a move experts say could make flying far less safe. Instead of a captain and co-pilot on the flight deck, as big jets have today, Single Pilot Operations (SPOs) will have just one pilot alongside an AI somehow designed to undertake the tough, safety-critical role of co-piloting.

This, airlines argue, will address a pilot shortage that has become economically debilitating for the industry. But SPO is meeting stiff resistance from pilot trade unions globally, who slate the idea as a cost-cutting measure. Worse, as a conference on SPO at the UK's Royal Aeronautical Society (RAeS) heard last month, rather than improving safety, AI co-pilots might quash a host of important human-human interactions.

Specifically, say SPO's critics, an AI co-pilot will eliminate the ways the flight crew monitor each other's actions at the controls, and it won't replicate how pilots can calm each other in stressful situations – such as coping with a "startle" response after a technical or weather issue develops. Pilots can also cover for each other after a rest break, when sleep inertia means it takes half an hour to get back full alertness. Will AI need heightened capability at that time? No one knows.

To be fair, SPO's backers plan a two-stage build-up to automation:

ADRIÀ VOLTÀ

first, a variant called extended Minimum Crew Operations (eMCO) will operate, in which there are two human pilots on board, but there will be extended periods where only one is at the controls, supported by AI, while the other pilot rests. Once that is perfected, SPO proper could begin single pilot gate-to-gate flights.

Tanja Harter, president of the European Cockpit Association, a pilots' union, told the RAeS summit that SPO doesn't address a key crew threat: pilot fatigue. While one pilot is resting under eMCO, she said, "the other one, sitting alone up front, will suffer increased fatigue". Other delegates agreed, citing boredom as a stressor. "Two brains and four eyes is a formula that works," said Harter.

Critics also ask how AI will cope with unexpected events, like the substation fire that saw London's Heathrow Airport plunged into darkness on 20 March. A sudden loss of ground data – from runway lights to landing localiser signals – could affect safe operation by an AI hungry for data to crunch.

A prime example of such an unexpected aviation event was the Qantas flight QF32 incident off Singapore in November 2010, cited by many RAeS speakers as a talismanic warning for SPO. When an engine exploded on QF32, debris severed 400 network cables and holed a fuel tank. The Airbus A380's flight computer, starved of accurate sensor data, instructed the pilots to transfer fuel from an unholed wing tank into the holed one – risking serious fuel loss. The pilots ignored the demand, but if that computer had been flying the plane, calamity could have ensued.

The furore over SPO has seen the European Union Aviation Safety Agency (EASA), which was asked by plane-makers Airbus and Dassault Aviation to investigate SPO's potential in 2022, push back any regulatory orders, with the idea set to be revisited after 2027. "We have refocused our plans to increase the level of safety on flight decks with new concepts of operations," EASA official Pedro Caetano told the RAeS conference.

Ultimately, the fate of SPO will be down to you and me, air transport economist Floris de Haan told attendees. "The power of the consumer will decide if SPO goes ahead," he said. So, how should *New Scientist* readers make their views known, I asked him. "Airlines frequently do research on customer acceptance of new technology, so write to the airlines you are loyal to," he advises. You heard the man. ▮

Paul Marks is a London-based journalist and a former technology news editor at *New Scientist*

Guest columnist

Feeling your (brain) age

Many of us have a brain that is older than our years. But there are plenty of things you can do to counteract this, says neuroscience columnist **Helen Thomson**

Helen Thomson was previously head of features at *New Scientist*, and specialises in life sciences, health and biotech. She is the author of books including *Unthinkable: An extraordinary journey through the world's strangest brains* and *This Book Could Fix Your Life*.

Helen's week

What I'm reading
The Thursday Murder Club *by Richard Osman.*

What I'm watching
Last One Laughing – *I can't bear anything heavy right now.*

What I'm working on
A proposal for my new book.

Annalee Newitz will be back next month. Up next week: Rowan Hooper

LATELY, my brain has felt decidedly ancient. I am only in my 40s, but last week I completely blanked on the date of my wedding anniversary, forgot the name of a friend's son and couldn't seem to concentrate on any work.

So when I was asked to write a column all about the brain, one question immediately came to mind: how old is mine? Years of research show that organs such as our heart, kidneys and ovaries don't all age at the same pace – and now we know that some people's brains also age faster than others. Not only that, we can test this pace of ageing and even slow it down.

One way to identify your brain's age is to simply take a picture. MRI scans show how, from around the age of 30, our brains start to shrink due to the atrophy of cells and their connections. Using thousands of these images, researchers can identify deviations that indicate whether your brain is ageing slower or faster than expected.

Genetic tests offer another insight – new research shows how seven gene variants have a particularly strong effect on accelerated brain ageing. Proteins, which are made by genes, also play a role. One large study analysed levels of specific proteins to calculate whether participants' organs matched their real age. It found that 1 in 5 people had an organ with a strongly accelerated age, and that those with an accelerated brain age were at an increased risk of dementia.

Research has also revealed that brains can age in different ways. When Christos Davatzikos at the University of Pennsylvania and his colleagues analysed brain scans from almost 50,000 people, they found five distinct patterns of brain ageing. They linked various age-related diseases to combinations of the five patterns. Intriguingly, the team found that certain lifestyle factors were associated with whether a person's brain atrophy followed a particular combination – smoking, drinking alcohol and eating a diet high in cheese, coffee or salt were associated with patterns that were linked to dementia, while people who drank tea and ate cereals were less likely to have brains that followed these patterns.

These correlations add to growing evidence that we can influence the age of our brains. It has even been suggested that 40 per cent of dementia cases could be prevented or delayed by lifestyle choices.

> **"Using thousands of MRI images, it is possible to find out if your brain is ageing slower or faster than expected"**

For that reason, you might want to find out your own brain age – and make some changes. One company established with this in mind is NeuroAge Therapeutics, founded by physician and neuroscientist Christin Glorioso. NeuroAge uses MRI scans to identify structural brain changes and white matter hyperintensities – damaged areas of tissue that increase your risk of stroke and dementia – combining them with the results of blood tests, genetic tests and cognitive games.

There is one catch: at $3194 for the full package, it is too expensive for most. It is difficult to find out the age of your brain from home or for free, but cognitive games can give you a rough idea. NeuroAge also offers a broad estimate of brain age based on how your performance fares against that of others your age. But they have their limitations, which Glorioso acknowledges. My brain turned out to be a sprightly 21 years younger than my actual age, but that was certainly more a reflection of my love of the memory tricks that helped me complete the tasks, rather than a true measure of a youthful brain.

Even without knowing your exact brain age, there are plenty of ways to ensure it stays younger for longer. Clinical trials have shown how those seven key gene variants associated with brain ageing can be targeted and their effects minimised by common supplements and diet choices, such as ensuring you have adequate vitamin D and eat enough omega-3 fatty acids. Among other things, vitamin D plays an essential role in maintaining the health of brain cells in pathways associated with memory and depression. Omega-3 fatty acids, meanwhile, have an anti-inflammatory effect in the brain and influence processes that mop up unwanted substances, such as the beta-amyloid peptides associated with Alzheimer's.

Building evidence also shows how learning new skills, speaking multiple languages and maintaining a rich social life can improve your cognitive reserve, a measure of your brain's resilience against damage.

There is one particularly simple intervention, too. Uncorrected vision has been linked with faster brain ageing, although scientists aren't sure why. The evidence is strong enough to convince me to book an eye examination – an easy step that might not help with remembering an imminent wedding anniversary, but will keep my brain looking (and feeling) younger for longer. ▮

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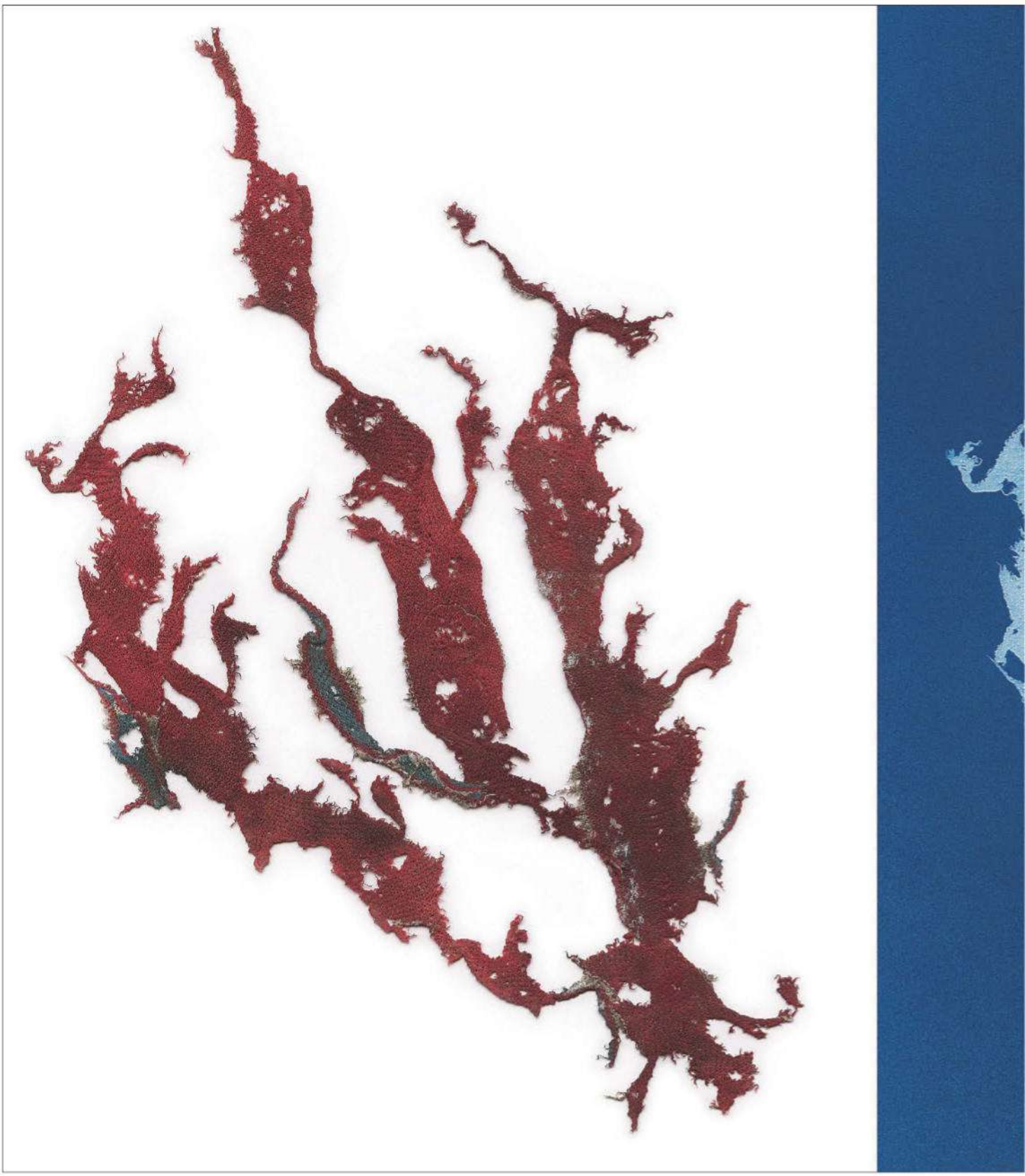

The artist in action
Watch Mandy Barker turn fabric waste into art
newscientist.com/video

Fashion blues

Mandy Barker
GOST Books

NEARLY two centuries ago, botanist and pioneering photographer Anna Atkins's influential book, *Photographs of British Algae: Cyanotype impressions,* wowed readers with its scientific power and artistry. In it, Atkins presented images of seaweed collected from British shorelines made using the cyanotype method, a printing process carried out by laying objects on chemically coated paper and exposing it to ultraviolet light, creating a cyan-blue backdrop.

In artist Mandy Barker's new book, *Photographs of British Algae: Cyanotype imperfections,* she uses the same technique to draw attention to the ongoing pollution crisis facing our oceans. Like Atkins, Barker also scoured the British coastline. Rather than finding natural beauty, however, she saw discarded clothing washing up onto the beaches. Her first find, she says, looked like seaweed. "It was kind of an attractive, beautiful piece of cloth." But as pieces of jackets, dresses, shoes, underwear and school uniforms started appearing, the scale of the problem quickly became apparent to her.

Inspired by the clothes' similar shape to seaweed, Barker decided to create new cyanotype prints (near left) from this found fabric (far left, not in the book) to replicate Atkins's work, with small but significant changes. She draws attention to the climate costs associated with fast fashion by inventing Latin names for the garments, such as *Delesseria tunica ictus* – a nod to both the shirt she found and a genus of red algae that Atkins photographed.

David Stock

Breaking new ground

Why are we driven to explore so widely and to challenge ourselves? A fascinating, bracing book unpicks the complex story, says **Elle Hunt**

Book
The Explorer's Gene
Alex Hutchinson
Mariner Books
(UK, 10 April; US, on sale now)

APPROXIMATELY 50,000 years ago, our ancestors – the first modern humans – set out from their African homeland in droves. We don't know for sure what prompted this mass uprooting (sometimes known as "the Great Human Expansion"), but our species' staggering geographic spread is proof of its success.

In relatively short order, humans made it to more or less "every habitable corner of the planet", writes Alex Hutchinson, a journalist, author and athlete. Even now, we test ourselves, take on ambitious challenges and seek out new ground – whether it's on a risky hike or a perilous migration.

The question Hutchinson poses in his bracing new book,

The drive to explore has taken humans to most of the habitable planet

The Explorer's Gene: Why we seek big challenges, new flavors, and the blank spots on the map, is why. It isn't as simple as saying humans are hardwired for adventure when many are very happy homebodies. Inherent to exploring, he argues, is effort, uncertain reward and the risk of failure – if not real danger. Why would we ever put ourselves through it?

Hutchinson brings professional and personal experience to bear on the question. A physicist by training, he was a middle-distance runner (including for Canada's national team) before pivoting to journalism. His book *Endure* was a *New York Times* bestseller and set him up as the "science of human endurance guy" before he started itching for new horizons again.

The Explorer's Gene is also deeply researched, citing a wide range of studies – some published as recently as last year – that shed light on why some are driven to seek adventure while others are content in their comfort zone.

There is no doubting which camp Hutchinson belongs to. The book opens with him on an arduous multi-day hike through the Newfoundland wilderness, and he uses stories from his globetrotting past to ground his discussion. To make sense of that questing impulse, Hutchinson draws from disciplines as diverse as robotics, economics, sports science and mythology, but even abstract concepts are clearly communicated and relevant.

Though he clearly feels the pull to explore, he doesn't judge those who don't. Instead,

"Few would volunteer for a one-way trip to Mars, but that doesn't mean remaining in our comfort zone forever"

The Explorer's Gene reflects a deep curiosity and desire to make sense of what could be seen as foolhardy or even senseless endeavours, like polar exploration or transatlantic crossings.

The title refers to the *DRD4* gene, which codes for a dopamine receptor in the brain and is associated (in some forms) with novelty-seeking behaviour and ADHD. It seems telling, writes Hutchinson, that the novelty-seeking gene variant is more prevalent in nomadic populations and first arose around 45,000 years ago – "just when humans began conquering the globe".

But genetics is only part of the story. Exploration has been shaped by external factors such as technology (making it more possible, and often less risky) and climate (driving population upheaval globally). Then there are the rewards, such as a shot at a new life or the glory of being first.

That thirst for newness and the unknown can manifest in other ways, too. While few of us would volunteer for a one-way trip to Mars or venture into the wilderness, as Hutchinson concedes, that doesn't mean remaining in our comfort zone forever.

As he discovers through his experience of orienteering, the benefits of neuroplasticity and engaging body and brain simultaneously support the idea of extending ourselves. Play, for example, is often overlooked in adulthood but can help us develop a tolerance for risk or a perspective that pays off elsewhere.

In his book's final chapters, Hutchinson argues that the many ways modern life leads us to be passive, such as blindly following our phone's directions, are undermining the depth and quality of our experience.

While there isn't one explanation for human exploration, novelty-seeking and chasing challenges, the physical and cognitive effort involved is satisfying, and the risk of failure makes our successes so rewarding. *The Explorer's Gene* challenges us to consider how to stoke that spirit without changing course entirely. ▮

MARCO BOTTIGELLI/GETTY IMAGES

Elle Hunt is a writer based in Norwich, UK

At what cost?

Drug trials are vital to medicine, but what of those taking part? A new book gives them a voice, finds **Alexandra Thompson**

Book
Valley of Forgetting
Jennie Erin Smith
Riverhead Books

STEVE RUSSELL/TORONTO STAR VIA GETTY IMAGES

Alirio, a coffee farmer and participant in the Medellín Alzheimer's drug trials

AFTER working in health journalism for over 10 years, I have covered countless drug trials – some runaway successes, others out-and-out failures, and everything in between. But I am ashamed to admit that I have rarely considered how these highs and lows affect the people involved.

In *Valley of Forgetting: Alzheimer's families and the search for a cure*, journalist Jennie Erin Smith puts them in the spotlight in her story of a rural community in Medellín, Colombia, hit by early-onset Alzheimer's disease.

Smith, a contributor to *The New York Times*, begins with Francisco Lopera, a neurologist at the University of Antioquia, Medellín. Lopera, who died last year, wanted to discover why so many local people experienced memory loss in their 40s, marking the beginning of a dramatic decline until their deaths, typically a decade later.

He found that affected individuals all possessed a mutation in a gene called *PSEN1* and that this drove their early-onset Alzheimer's. The gene is involved in breaking the peptide bonds between amino acids in proteins, and mutations to it can result in the formation of clumps of amyloid protein – the hallmark of Alzheimer's in the brain.

The researchers also tested the descendants of people with the condition to find out who carried the mutation. The child of someone with the mutation has a 50/50 chance of inheriting it: they either dodge the bullet or almost definitely get early-onset Alzheimer's.

With this knowledge, Lopera and his team decided to test the monoclonal antibody crenezumab. They hoped it would prevent or slow this amyloid clumping, thereby delaying or easing Alzheimer's symptoms in people who were genetically predetermined to develop the condition.

However, the researchers didn't reveal the results of the genetic tests until their drug trials (some of which were paused or ended due to a lack of efficacy) had concluded. The participants could then choose whether to learn their fate.

For many of them, learning their genetic status was why they signed up. But finding out meant an interminable wait for many, like the 38-year-old woman who wanted to know whether she might pass the mutation to the baby she yearned for. This was no hypothetical situation: Smith later learned of a woman around this age who developed dementia after starting a family.

The tribulations didn't stop there. Smith also met a woman called Lina whose mother, Amparo, had Alzheimer's and suddenly disappeared. Lina claims that trial staff made no effort to help find her. She said that when researchers had needed anything – from an MRI scan to a cognitive test – Amparo showed up. But in her moment of need, they weren't there for her.

In the end, crenezumab was no better than a placebo at slowing Alzheimer's. This was announced in a press conference with no relatives of the participants present – and it was held in English, which most of those involved didn't understand. They found out via WhatsApp.

The affair also raises the question of how things could have played out. Drugs are free for trial participants, but if crenezumab had been effective enough for approval, who would have been able to continue paying after the trial ended? How would Colombia have ensured participants who benefitted had continued access? Most of them weren't well off – some signed up only because they received free diapers for incontinent relatives.

The book left me aching and enraged for what they and others have endured in the name of scientific research. Clinical trials are essential, but we must not ignore the turmoil of the participants – people to whom Smith has finally given identities. ▮

New Scientist *recommends*

Bethan Ackerley
Subeditor
London

Weather Girl, at London's Soho Theatre until 5 April, is a frantic, funny show about the climate crisis. Written by Brian Watkins, Julia McDermott (below) is Stacey, a local weather forecaster in Fresno, California. Sandwiched between segments on dog shows and testicular tanning, she reports on droughts and wildfires with a winning smile – until she snaps.

The play is an attack on wilful ignorance – not only of climate change, but of the plight of women like Stacey, whose appearance is coveted and policed by colleagues and viewers alike. She must pretend that nothing is wrong and everything is permitted.

PAMELA RAITH

Everyone knows Stacey isn't OK and the world is burning, but admitting that means facing up to too many convenient lies.

The unravelling of Stacey's persona (what you might call the uncanny valley girl, a too-perfect ultra-femininity) is electrifying. Think *Network* meets *Legally Blonde* meets *I Saw The TV Glow*.

The film column

Copy that Life is hard on icy Niflheim, and the colonists need expendables: humans who take the flak, die and get cloned. In *Mickey 17*, our hero is left for dead, only to return and find he has been "reprinted". What then, asks **Simon Ings**

Simon Ings is a novelist and science writer. Follow him on X @simonings

WARNER BROS. PICTURES

Mickey (Robert Pattinson) can be reprinted when he dies – if he can take it

IN *MICKEY 17*, Robert Pattinson stars as the "expendable" Mickey. Put him in harm's way and if he dies, you can just print another. And for human colonists on the ice planet of Niflheim, there is plenty of harm to get into. There's the cold. And the general lack of everything, so the settlers must count every calorie and weigh every metal shaving. Most troublesome are the weevil-like creatures that chomp through the planet's ice and rock. What they will do to the humans' tin-can settlement is anyone's guess.

Mickey has been reprinted 16 times already, mostly because medical researchers have been vivisecting him in their effort to cure a plague. The one thing that doesn't kill him, ironically, is falling into a crevasse and being swallowed by a weevil. Who saw that coming? Certainly not the other colonists: when Mickey returns to camp, he finds he has already been reprinted. And "multiples" aren't permitted...

As science fiction MacGuffins go, this one is nearly a century old, its seeds sown by Aldous Huxley's *Brave New World*. And we can't say director Bong Joon Ho, celebrated for savage social satires like *Parasite* and *Snowpiercer*, "rediscovered" it. Actor Sam Rockwell turned in an unforgettable tour de force as two hapless engineers in Duncan Jones's *Moon* over 15 years ago.

The point about MacGuffins is that they are dead on arrival. They have no inner life, no point. They stir only when characters get hold of them and use them to reveal who they are. Take invisibility. It's hard to conceive of an idea more boring, yet H. G. Wells's invisible man is a figure out of nightmare – one that, to judge by the number of movie remakes, the culture cannot get out of its head.

"The one thing that doesn't kill Mickey is falling into a crevasse and being swallowed by a weevil"

What does Ho say with his "multiples" MacGuffin? It depends where you look. For the most satisfying cinematic experience, keep your eyes fixed on Pattinson. Asked to play a man who has died 16 or 17 times already, he turns in two quite independent performances, wildly different from each other and both utterly convincing. Mickey 17 is crushed by his deaths; Mickey 18 is rubbed raw to screaming by them.

Pattinson aside, all in all, *Mickey 17* is embarrassingly bad. It takes a bright, breezy, blackly comic novel by Edward Ashton, strips out its cleverness and gives us Mark Ruffalo's unfunny Donald Trump impression as the colony leader and Naomi Ackie (as the Mickeys' love interest) inexplicably throwing a foul-mouthed hissy fit.

Anyone who read Ashton's book and watched Ho's *Snowpiercer* might be forgiven for expecting *Mickey 17* to be a marriage made in cinema heaven. For one brief moment in its 2-hour-and-17-minute run-time, a cruelly comic dinner party scene seems about to tip us into a much better film – a satire on power and hunger.

Then Tim Key turns up in a pigeon costume. I adore Key, but sticking him in a pigeon costume in the hope it will make him even funnier is as wrong-headed as it is insulting to his talent.

When a film goes this badly awry, you have to wonder what happened in the editing suite. My guess is that some bright spark from the studio decided the film was too difficult for its audience.

Oh, enough! I'm done. Even the weevils were a disappointment. In the book, they were maliciously engineered giant centipedes. How, I ask you, could a famously visual film-maker not even have embraced them? ▮

Film
Mickey 17
Bong Joon Ho
On general release

Simon also recommends...

Film
The Platform (El Hoyo)
Galder Gaztelu-Urrutia
Netflix
Date night looming? Then why not watch as a Spanish dystopia sends a table laden with food through the ever more hellish levels of a vertical prison?

Book
The Two-Timers
Bob Shaw
Gateway (Gollancz)
One of sci-fi's most genial writers, Bob Shaw pulled no punches in this early noir thriller about a man trying to save his wife from... himself!

Editor's pick

Seeing red raises more consciousness questions

15 March, p 18

From Matthew Stevens, Sydney, Australia

You report on a study suggesting we all perceive colours the same way, subjectively speaking. While the study seeks to offer an answer to this long-standing philosophical question, I have long pondered a similar one that can't be answered, or even tested, prompting me to frame it as a conjecture: that our sense of self, or "me-ness", has the same qualia, or "taste", for every one of us. That is, when I think of "me", the way I experience myself is identical to the way everyone else experiences him or herself. Further, I propose that this extends to other animal species. It would be intriguing to at least probe this.

The power struggle over birth, parenting and more

8 March, p 22

From Sam Edge, Ringwood, Hampshire, UK

Penny Sarchet's review of the book *Motherdom* was refreshing. Having successfully medicalised pregnancy and childbirth, and so brought it under the control of mostly upper-middle-class, white, male, establishment authority figures, the same is being done with child rearing using spurious and misleading references to neuroscience. In the UK, at least, the education system has gone the same way, having been reshaped to fit the political prejudices of those in power rather than following the evidence.

Protest per se is pretty futile, so try this instead

15 March, p 15

From Carl Turney, Orbost, Victoria, Australia

Regarding the story "Thousands join 'Stand Up for Science' rallies across the US". Given the often small long-term impacts and benefits of protest marches and rallies per se, plus the many hours consumed in their preparation and attendance, the most effective and efficient activity is to collect the contact details of as many attendees as possible. A large pool of proven and motivated supporters can then be surveyed and organised to assist their colleagues who live in the (politically priceless) marginal electorates, and inform the (politically priceless) swing voters in such strategic electorates of the merits of one's cause.

Space/time breakthrough to save your old iPhone?

8 March, p 8

From Adam Whitehouse, Newcastle-under-Lyme, Staffordshire, UK

The recent discovery that memory requirements for computation can be drastically reduced raises an intriguing question: could this principle help extend the lifespan of smartphones and the like? Many older devices struggle to run newer operating systems due to fixed memory constraints. If we could rewrite OS processes using the newly discovered approach, could this allow modern updates to run efficiently on older hardware, delaying obsolescence?

On studying first aid behaviour in mice

1 March, p 11

From Ingrid Newkirk, People for the Ethical Treatment of Animals, US

Researchers rendered mice unconscious – not benign – and then presented them to other mice who tried to resuscitate them. Such "research" won't benefit anyone, let alone save anyone's life, yet the mice were significantly disturbed. It adds only to the knowledge that despite "discovering" time and again that mice and other species have feelings, researchers ignore the evidence and carry on using them as if they did not.

From Calliope Irving, Seaford, East Sussex, UK

You quote a researcher saying "the recuperative behaviour isn't an analogue of CPR... but more like performing basic first aid to ensure an unconscious person can breathe". As a retired emergency medical technician, I can confirm CPR is, at its core, basic first aid to ensure a person can breathe and therefore the mouse behaviour can be classed as basic intentional CPR.

Not all is lost when code-busting computers emerge

Letters, 15 March

From Eric Kvaalen, Les Essarts-le-Roi, France

Simon Goodman worries that quantum computers will leave our online bank accounts open to invasion. Actually, other types of cryptography have been developed to get around this vulnerability. Banks and e-commerce will start to use them instead of existing methods if and when necessary. The problem is that today's encrypted messages can be stored, and probably are. These will be able to be decrypted. So I agree with Simon that quantum computing isn't necessarily a good thing.

They came from a faraway planet ruled by children

Letters, 15 March

From Hillary Shaw, Newport, Shropshire, UK

Carl Zetie suggests we "send 100 million sperm and eggs, not 100,000 people" to colonise an alien planet, but leaves the story of raising the offspring to others.

You would need a machine to provide food, made in situ, for the resulting infants, and much more. They may see it as a sort of God. But as years pass, a Reformation-like split might develop, with some breaking away from the machine to develop better technologies.

It could all lead to an advanced society that will explore the universe and maybe find a quaint, primitive, less-developed world inhabited by creatures like themselves, but less sophisticated. We will make great pets for them.

Will mirror drugs become an environmental issue?

1 March, p 34

From Jim McHardy, Clydebank, Dunbartonshire, UK

The idea of mirror cells producing long-lived pharmaceuticals seems a bit too much like the creation of "forever chemicals" to me.

Civilisation's true start: let's go with public loos

Letters, 15 March

From Paul Whiteley, Bittaford, Devon, UK

I agree with Trevor Prew's sentiments on drains as an indicator of the first true civilisations. I would go slightly further and say that public conveniences are a key indicator. In my part of the country, funding of many public toilets was stopped and they closed. It seems we are less civilised than before.

For the record

Lisa Feldman Barrett is at Northeastern University in Massachusetts (15 March, p 30).

Accretion disc light from a black hole in galaxy 3C 186 was blueshifted relative to its galaxy as a whole (15 March, p 19).

Pufferfish acquire the toxin tetrodotoxin from their diet, rather than producing it themselves (15 March, p 11).

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DANIEL STOLLE

Autism's missing girls

For decades, science has overlooked autistic girls and women. Now we are finally waking up to the biases in autism research – and what we have discovered changes everything, says neuroscientist **Gina Rippon**

IN CHINA, it is known as "the lonely disease". The Japanese term translates as "intentionally shut". Across the world, there is a perception of autistic people as aloof, socially awkward and isolated, seeming to not only lack the kind of automatic social instinct that enables successful interaction, but also the desire to achieve it. There is also a perception that autistic people tend to be men.

For decades, researchers – myself included – have thought of autism as a predominantly male condition. The more we studied boys and men, the clearer the picture of autism that emerged – or so we thought.

Today, we have come to realise that we were missing a huge piece of the puzzle all along. Not only have we been failing to recognise autism in vast numbers of women and girls – preventing them from getting a diagnosis and support – but we have now made the profound discovery that the female autistic brain works differently than the male one, especially when it comes to social motivations and behaviours. As a result, an entirely new picture of autism in girls is crystallising, forcing a radical rethink of everything we thought we knew.

Autism is a neurodevelopmental condition, commonly diagnosed by the age of 5. Current standard diagnostic criteria refer to "persistent difficulties with social communication and social interaction", as well as "restricted and repetitive patterns of behaviours, activities or interests to the extent that these limit and impair everyday functioning".

The World Health Organization estimates that 1 per cent of children worldwide are autistic, but this figure is probably much higher, with estimates that up to 50 per cent of autistic people remain undiagnosed.

The seed of the belief that autism is a male-centric condition was planted quite early on, with Hans Asperger, one of the so-called "fathers of autism", specifically referring to a form of extreme male intelligence in his case studies (which all looked at boys).

By the 1960s, early prevalence studies were reporting a male-to-female ratio of 4:1, a figure often quoted today on autism websites and in advice manuals, as well as in research papers.

Diagnoses of autism began to soar in the 1980s thanks to a broadening of the definition of the condition, incorporating a much greater range of indicative signs and levels of support needs. And this century, a more widespread recognition and awareness of autism has caused a further surge. Yet all this has only widened the gulf between diagnoses in girls and boys (see "Autism prevalence among 8-year-olds in the US," page 35), with some reports of male-to-female ratios of 15:1.

The general consensus was that of course there are autistic girls and women, but their social difficulties and repetitive patterns of behaviour are less marked. A fixed diagnostic description of autism had emerged: this is what it is like in boys and men, so this is what autism is like. The belief in the "maleness" of autism also affected the public's conception of it, often fed by media characterisations such as Dustin Hoffman's character Raymond in *Rain Man*.

Traditional view

This traditional view also fed into neuroscientific research into why girls were less likely to be autistic. One idea was a "female protective effect" – suggesting that specific aspects of female biology served as some kind of buffer, requiring a much stronger genetic influence before the condition emerged. In the same vein, a central role for testosterone has been proposed in the development of autistic brains. Indeed, one early neuroscience model of autism proposed that it was causally linked to "an extreme male brain", firmly based on the accepted maleness of autism.

But it is perhaps in the field of cognitive neuroscience, exploring the links between brain and behaviour, that the male bias has been most evident. Autism clearly runs in families, with estimated heritability ranging from 40 to 90 per cent. Genetic studies strongly indicate multiple differences in brain development between autistic and non- autistic brains, which remain the focus of most research programmes. But there is currently no biomarker for autism, so it is only recognisable behaviourally. This means models of behaviour that most closely match the accepted picture of autism serve as frameworks for brain-imaging studies. Because a core diagnostic characteristic of autism is "persistent difficulties with social communication and social interaction", a major focus of autism brain-scanning studies has been on the so-called social brain.

The social brain hypothesis has long argued that our brains have evolved to manage social interactions and relationships, enabling us to navigate the complexities of human society. This requires an awareness of not just an individual self, but also other selves, their thoughts, beliefs and intentions, and how these might affect interactions between an individual and other people. This forms the basis of what could be termed a social instinct, which automatically oils the wheels of social interaction. We also have a powerful drive to be social – a need to join or be accepted by social networks – which can underpin many aspects of behaviour.

The human brain is thus equipped with complex networks responsible for the acquisition and retention of social knowledge, such as the recognition of facial expressions or tone of voice. Emotional and motivational processes in the brain then identify the positive or negative aspects of social behaviour. And these, in turn, speak to the action networks, which help us to respond with socially "appropriate" behaviour, for example, following the rules of turn-taking in conversation or respecting personal space.

Once cognitive neuroscientists could model core processes of social behaviour in the brain, the idea was that they could map activity in these social brain systems in a brain scanner and hopefully identify the brain differences that underpinned the social difficulties characteristic of autism.

This offered a fruitful approach for autism neuroscience researchers. Between 1990 and 2020, there were many hundreds of studies comparing patterns of activity and connectivity pathways in social brain networks in both ›

DEAN HINDMARCH/SOL STOCK/GETTY IMAGES

Our social brains help us navigate group situations

autistic and neurotypical participants. A powerful consensus emerged that, particularly in the social reward networks, there were lower levels of activity and/or reduced connectivity in autistic brains. Such activity was associated with suboptimal social behaviour – poor emotion recognition, for example, or minimal emotional reaction to negative social experiences, such as social rejection. Particular attention was drawn to the striatum, a brain structure heavily involved in reward-processing and reinforcement-learning. The underactivity in this region resonated well with the classic autism phenotype of a socially withdrawn individual, apparently lacking the motivation to make contact with others. Such findings offered the best insights to date into the brain correlates of autism.

But these promising developments were based on highly biased datasets. Last year, I did some detective work and published a review of more than 120 brain-imaging studies specifically looking at social brain differences in autism, revealing that nearly 70 per cent of them tested only male brains (or included just one or two female brains). Of the more than 4000 autistic participants tested overall, fewer than 10 per cent were female. This is more widely reflected in the entire body of autism brain research. A review of 20 years of such work revealed that, of 1428 articles on brain structure and function in autism, almost 30 per cent studied only male brains; in 77 per cent of the remaining studies, sex differences weren't assessed or sex was treated as irrelevant in the analyses.

Perhaps most concerning of all, very few of the discussions drew attention to the fact that only male brains were being measured. Results were reported in terms of insights into autism or autistic behaviour.

To be fair to the neuroscience community, the failure to include girls and women in research cohorts isn't just a reflection of what's called the male-spotlight problem, where a belief in the maleness of autism constrained research design. It is also tied to another consequence of that belief: the almost-impossible obstacle course that autistic girls and women face in order to get a diagnosis.

Early concerns about children's behaviour are more likely to be dismissed if they are girls. Page Pelphrey, about whom I write in my book, is married to one of the world's top autism researchers, Kevin Pelphrey, and is the mother of an autistic daughter and an autistic son. With her daughter, Frances, the couple was told to "watch and wait", and "you have a girl, it's not autism". With their son, diagnosis "was a snap". Online information, meanwhile, slants towards the experience of boys.

Teachers, who should be well-placed to spot behavioural differences in the children they educate, are also prone to gender bias in autism. A 2020 study reported that teachers given identical vignettes of hypothetical children showing atypical behaviour were significantly more likely to suggest a child called "Jack" was autistic and in need of support than if the child were named "Chloe".

If a girl gets as far as a diagnostic assessment, there is clear evidence that male bias is embedded in the "gold-standard" tests, with the content of the interview questions and the indicative scenarios validated on male-only samples. As many as 80 per cent of autistic girls remain undiagnosed by the age of 18.

> **"There is a growing realisation that autism presents differently in girls and women"**

These tests also make it much harder for scientists to recruit autistic women into their studies. Even when women show high levels of autistic traits, the tests often determine that they just aren't autistic enough.

In the past decade, triggered by a wave of powerful personal testimonies from late-diagnosed autistic women, as well as a call to arms from members of the autism research community, the default male model of autism has finally come under scrutiny.

Newer neuroscience studies have homed in on sex differences, finding that autistic girls and women might present with different patterns of atypical behaviour, associated with different patterns of atypical brain activity. In particular, these studies revealed that the "robust" model implicating underactivity in the autistic social brain, established by several decades of research with mainly male participants, doesn't generally apply to girls and women.

One study, for example, found that autistic girls had higher activity in areas associated with social reward than autistic boys – and even neurotypical girls – pointing to higher than usual levels of social motivation. Another found greater connectivity between key social brain networks in autistic girls compared with boys. And a third study looked at over-responsivity in sensory systems, which is usually thought to be characteristic of autistic

behaviour and is linked to powerful aversive responses to loud noises or bright lights. In girls, the networks underpinning this behaviour seemed to have additional connections to those parts of the frontal areas in the brain involved with monitoring social feedback. In other words, there appeared to be a female tendency to monitor and control such over-responsiveness to avoid social embarrassment.

All of these findings suggest that the female participants have a more powerful proactive behavioural drive for social engagement and highly reactive responses to social rejection.

Put plainly, these findings don't fit into the (male-based) model of stereotypical autistic aloofness and intentional social isolation. But they do fit with a growing realisation that autism presents differently in girls and women – or, perhaps more precisely, the current measures of autism don't accurately capture their differences. Their lower scores on measures of social dysfunction don't mean they have milder difficulties.

Rather, they reflect what turns out to be a lifelong pattern of masking or camouflaging, devising strategies to disguise or compensate for autism-related difficulties, particularly linked to social engagement. These may involve intensive study of the social behaviour of others and the generation of social guidance scripts, such as how long to engage eye contact or laugh at jokes, which will then be exhaustively rehearsed and followed whenever a social situation is encountered. It is the recent findings concerning such camouflaging behaviour that have really marked the emergence of an understanding that autism may present differently in girls and women.

> **"Camouflaging is linked to high levels of anxiety, exhaustion and stress"**

This behaviour may imply an aspect of social compliance, with girls and women more likely to be "trained" to be quiet, calm and well-behaved. It should be stressed that there is huge variation and overlap, with some boys and men being more "chameleon-like" and some girls and women displaying the more typical signs of autism – though these individuals will find it easier to get a diagnosis. Not all autistic men are socially withdrawn, just as not all autistic women are desperate for high levels of social engagement.

Masking may seem like a successful trick. But, in fact, camouflaging in autistic girls and women is associated with high levels of anxiety, exhaustion and stress, as well as chronic depression and suicidal ideation. So the persistence of such damaging behaviour suggests an extraordinarily powerful drive to be social and an equally powerful wish to avoid social rejection, exactly as emerging findings in neuroscience suggest.

Given these new discoveries, some researchers have published new estimates of the male-to-female ratio in autism, which hint that it is a lot lower than the history of autism has led us to believe. In particular, large-scale surveys of autism traits in the general population suggest that we might be looking at equal numbers of autistic girls and women and boys and men.

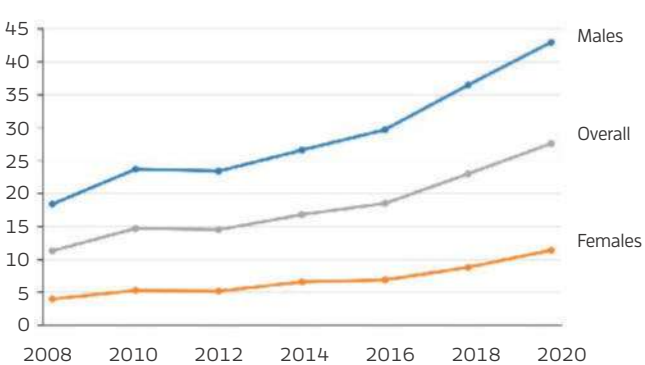
Behind the mask

Tracking the story of autism's missing women reveals the power of unchallenged belief to bias a whole clinical system, from awareness and recognition to definition, diagnosis and scientific research, distorting the public consciousness and sustaining unhelpful stereotypes. But the newly emerging awareness of these differences should begin to break down the barriers that autistic women have confronted and inform a more accurate – and inclusive – awareness of what autism can look like.

Better questions can be asked, and adjustments to diagnostic criteria should more accurately capture the lived experiences of all autistic people, not just boys and men. Autistic women and parents of autistic daughters will no longer be overlooked or ignored. Researchers can begin to draw on more balanced populations of autistic individuals and design measures that reflect how autism presents in all people. This won't just be better for autistic girls and women; it will also revolutionise our understanding of the condition as a whole. ∎

Autism prevalence among 8-year-olds in the US

Rates are per 1000 children



SOURCE: CENTERS FOR DISEASE CONTROL AND PREVENTION

Gina Rippon is a professor emeritus of neuroscience cognitive neuroimaging at Aston University, UK. Her latest book, *The Lost Girls of Autism*, is on sale now

LaAA!
BANANA

SCOTT WILSON

Culture shock

The discovery that animal culture is far more sophisticated than we thought has created a headache for biologists trying to explain why ours is so distinct, finds **Colin Barras**

WE ALL know the story: give every chimpanzee on the planet a typewriter and wait until something monumental occurs, either the recreation of the complete works of William Shakespeare or the heat death of the universe. Last year, mathematicians concluded the chimps would never achieve the former – the likelihood of one typing even the more modest "bananas" in its lifetime is a meagre 5 per cent. That some of our closest relatives fail this test speaks to how human culture is like nothing else in nature. Ask biologists to explain why this is, however, and things get complicated.

The problem became clear this century as studies revealed that culture, far from being uniquely human, is present across the animal kingdom, from whales to ants. This has encouraged researchers to search for the key ingredient that explains why our culture – and ours alone – flourished.

It hasn't been easy, and for a surprising reason: animal cultures are far more sophisticated than we assumed. We once thought they couldn't become more technologically advanced, yet research published a few months ago suggests they can. We also suspected that animals lacked the smarts to learn complicated behaviours from one another – but last year, we discovered that even bees may be sufficiently brainy to do so. "Views have changed," says Edwin van Leeuwen, an animal cognition researcher at Utrecht University in the Netherlands. "We now know much more about animals than we did before."

In updating our expectations of animal cultural behaviour, though, we seem to have made explaining the culture gap much harder. So, how do we understand the divide?

For decades, few researchers were prepared to accept that any non-human animal had culture. Indeed, it was Eurocentric culture that denied animals theirs. Going back at least as far as Plato, 2300 years ago, Europe's great thinkers imagined the existence of a chain of being with humans distinctly above all other animals, says Alice Bridges, a cognitive scientist at the University of Sheffield, UK. Elsewhere in the world, "things tend to be viewed as a lot more interconnected", she says.

What is culture?

Perhaps it is unsurprising, then, that one of the first people to suggest that animals might have cultural traditions roughly akin to our own was Japanese biologist Kinji Imanishi. He began advocating for animal culture in the early 1950s as part of a broader argument that some animals have human-like characteristics – and faced ridicule from some European and North American researchers for doing so, says Bridges. But evidence continued to mount – including the discovery in the 1960s of regional accents in North American sparrows. It was in the 21st century, however, that research into animal culture exploded.

This may baffle many members of the general public, at least in the West, who might struggle with the idea of animal culture. But this is largely because in Western countries, people typically associate culture – a fuzzy term, with multiple definitions – with artistic and intellectual activities. Biologists have come to adopt a less human-centric definition. "Culture is shared," says van Leeuwen. This means that any behaviour – whether that be using sticks to dig for termites or learning to play the piano – becomes cultural through the act of spreading to other community members. Use this definition and animal culture turns out to be common. Nevertheless, no animal cultures rival the complexity of our own, and biologists became eager to know why. ›

In the early 2000s, many began to favour one interpretation in particular. It is clear that our cultural behaviours and tools change as they spread to new populations and pass down the generations, often becoming more sophisticated in the process. The argument went that other animal cultures don't do this, meaning we alone have what biologists have dubbed "cumulative culture".

A few years later, Claudio Tennie, a behavioural biologist now at the University of Tübingen, Germany, and his colleagues suggested an idea to help explain the lack of cumulative culture – in chimpanzees, at least. Chimps, they argued, don't have this because they aren't very good at learning how to master a new skill from each other. Tennie acknowledges that this idea sounds counterintuitive, not least because it clashes with what popular culture has to say about chimps. "We often talk about aping someone's behaviour," he says. As such, it's easy to think we know what is happening when an unusual skill – using stone tools to crack nuts, for example – spreads through a chimp population, he says: one chimp innovated the behaviour; the others picked it up through imitative copying.

But Tennie and his colleagues argued that this can't be what is really happening, because their experiments suggested that chimps are poor imitators. Tennie says this means each chimp must develop its skill set independently. Under this scenario, the first chimp discovers how to crack nuts using stones. A second chimp is intrigued, but, being unable to ape the behaviour, it instead chooses to examine the nut-cracking site once the first chimp has moved on. Guided by the presence of stones and uncracked nuts, this second chimp begins experimenting and eventually works out for itself how to crack nuts. "It's a process of reinventing the wheel," says Tennie.

Can apes ape?

Crucially, says Tennie, this imposes a limit on cultural development. Many of our cultural tools have accrued so many changes over the generations that they are now too elaborate for a novice to reinvent from scratch. It is highly unlikely, for instance, that an untrained individual could build a violin after simply examining a Stradivarius: what is needed is guidance from an expert instrument-maker. If chimpanzees can't rely on that guidance because they don't imitate one another, their culture is restricted to innovations that any individual chimp could invent for itself – innovations that lie within what Tennie calls the zone of latent solutions (ZLS).

"The difference may be in the way human culture continues developing"

Over the past decade, Tennie and his colleagues have collected additional evidence that they argue favours the ZLS hypothesis. But the idea has plenty of critics who insist that chimps and some other animals, including pigeons, learn through imitative copying and do have cumulative culture. A particularly clear example was published last year by a team that included Cassandra Gunasekaram, an evolutionary ecologist at the University of Zurich in Switzerland and Andrew Whiten, an evolutionary psychologist at the University of St Andrews, UK. The researchers knew that chimps in some wild populations have complex toolkits – for instance, they may use stout sticks to poke holes in termite nests, then insert thinner sticks to fish for the insects.

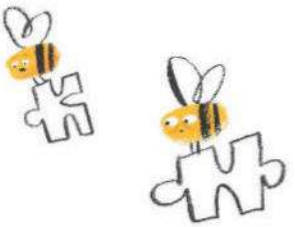
Using genetic data, the team discovered that different chimp populations with such toolkits are particularly likely to have been in contact with one another within the past 15,000 years. What's more, these links – and the links with populations that use simpler tools – suggest the toolkits have spread from population to population, becoming more technologically advanced as they did so. "However, since chimpanzee migration rates are limited, this also implies that the spread and accumulation of these tools is limited," says Gunasekaram.

Strictly speaking, this result doesn't directly challenge the ZLS hypothesis. Chimp cultural tools could become a little more advanced while remaining simple enough for each individual to reinvent them. But a few months before Whiten and his colleagues published their findings, two studies undermined the idea that this limitation exists. Both concluded that animals can indeed learn elaborate skills that they couldn't invent for themselves by watching another animal performing them, in much the same way that a novice can learn to make violins by watching a professional instrument-maker.

The studies – one in chimpanzees and one in bumblebees – were far from easy to conduct. By necessity, they both involved presenting the animals with a puzzle that was too tricky for any individual to solve on its own. Then came the difficult part: isolating individual animals and teaching them how to solve the puzzle.

Some biologists argue that pigeons learn through copying and so have cumulative culture

STELIOS MICHAEL/ALAMY



KAY ROXBY/ALAMY

Bees may be able to develop skills through imitating one another

In the case of the bees, this meant teaching one of the insects that it couldn't access a food reward visible behind a clear plastic sheet by making a beeline straight towards it. Instead, the bee had to take a detour and push a lever that would then allow it to move the plastic and reach the reward. "That wasn't at all trivial to the bee," says Bridges, who led the study. It was only by bribing the insect with a smaller reward near the lever that the researchers could encourage it to make the detour. They then had to wean the bee off the bribe until it would make the detour simply to gain access to the original, large reward. The whole training process took two days. The final stage of the experiment involved having the trained bee solve the puzzle in the presence of an untrained bee. Remarkably, within 10 hours, some untrained bees began following in the footsteps of the trained bee and learned to take the detour themselves. "When we saw the bee learn the solution from the demonstrator, we all went wild," says Bridges.

It was the same story with the chimps. This study, led by van Leeuwen, involved placing what was in effect a peanut vending machine in a large, forested enclosure at the Chimfunshi Wildlife Orphanage Trust in Zambia, which is home to dozens of chimpanzees. Over the course of three months, none of the chimps worked out that they could dispense peanuts by opening a drawer on the machine, inserting a wooden ball and then closing the drawer again. But once van Leeuwen and his colleagues taught a couple of them how to operate the machine, the skill quickly spread to other community members.

Tennie isn't convinced that the experiments are a fatal blow to the ZLS hypothesis. He suspects, for instance, that the chimps could have worked out how to operate the vending machine eventually. He says they may have failed to do so in the three months they were given because the enclosures at Chimfunshi are many hectares in size, offering distractions that can fill the chimps' days. But others say the studies are valuable. "I think they push the boundaries back on our understanding of whether animals can learn things that go well beyond what they could individually work out," says Whiten. If that view is correct, the studies imply that other animal cultures may be more complex than we had thought – even in creatures like bumblebees, whose brains are about the size of a sesame seed. They also suggest we are further than ever from explaining why human culture is so clearly different from any other on Earth.

Lacking in motivation

There are, however, possible ways forward. One might be to recognise that there is a difference between demonstrating that animals can learn difficult skills from each other and showing that they do this regularly enough to influence their cultural development.

For instance, although Whiten thinks chimps can copy one another, he thinks that, compared with humans, they are much less motivated to do so. He speculates that this might reflect their broader evolutionary history. Our ancestors left the forests and began exploring new environments and exploiting new foods, particularly nutrient-rich meat, so natural selection may have favoured hominins who were willing to learn useful skills from one another. Chimps' ancestors stayed in the forests, maintaining their traditional way of life, so natural selection might have favoured individuals with a more conservative outlook. "Despite their intelligence and their ability to learn from others, chimpanzees are just not that willing to try something new," says Whiten.

For Thomas Morgan, an evolutionary anthropologist at Arizona State University, meanwhile, the difference may be in the way human culture continues developing almost indefinitely, going from stone tools to metal axes to industrial log-splitting machines. "Humans can and do push all that way, but basically all other species seem to run up against some sort of constraint," he says.

Last year, Morgan and Marcus Feldman, a biologist at Stanford University in California, argued that brains – and the way individuals mentally represent actions and goals – might help explain this. For instance, if a human wants to produce a small stone figurine, they must hold that idea in their working memory while they scout for carving tools and then turn an unshaped stone into the artwork in their mind's eye. The evolution of larger brains – perhaps fuelled by our ancestors' taste for highly nutritious meat – might have given us the working memory capacity to dream up and carry out such complex tasks. Animals with smaller brains and more limited working memory capacity may struggle to do so. "I think it's totally plausible that if you have more working memory then that gives you a bigger canvas to see the bigger picture," says Morgan.

Put the pieces together and this suggests that several factors helped widen the culture gap. Genetics may have played a part in encouraging our ancestors to value innovation over conservatism. Behaviour may have played a part in allowing us to exploit new foods that fuelled brain growth. And larger brains may have played a part by allowing us to store more information, think up new ideas and retain our focus on those ideas. "There is no single silver-bullet explanation," says Whiten.

Tennie broadly accepts this conclusion. "When we first outlined the ZLS hypothesis, my colleagues and I stated that several things had to come together for human-like culture: cooperation, teaching and so on," he says. But he adds that researchers know there is more to do than simply declare that the picture is complex. The challenge now facing biologists is to devise clever experiments that assess exactly which factors played a key role in catalysing our cultural development, and which were of lesser importance. After all, science has a culture too, and experiments are one of its core features. We may need many more of them to fully solve the mystery of the culture gap. ▮

Colin Barras is a freelance writer based in Ann Arbor, Michigan

Keeping time

To prepare to redefine the second, scientists had to take the world's most precise – and delicate – clocks on a perilous journey, says **Karmela Padavic-Callaghan**

ON A a large table draped with hundreds of cables, a maze of mirrors and lenses bounces and guides a thin beam of laser light. It culminates at a silvery capsule, which holds 40,000 strontium atoms cooled to within a whisker of absolute zero. This delicate edifice is an optical clock, one of the world's most accurate timepieces.

Instruments like this aren't exactly designed to be portable – which makes it more than a little surprising that the operators of one such device at the German national metrology institute packed it into a trailer and sent it hurtling down a motorway. It was the start of a perilous journey: a bad jolt could disrupt the beat of its precise ticks. But it was necessary.

That was because, in 2022, scientists globally agreed that we should start work on redefining the second based on our latest and greatest timekeeping technology: optical clocks. However, this meant bringing together several of the world's best specimens for comparison.

Doing so proved a huge challenge, but it will surely be worth the trouble. A new definition of the second will be profoundly consequential for nearly every other measurement that scientists use to describe nature, from speeds to masses and more. Our efforts to define it more precisely, then, will ripple out across our entire view of the world. "This was the first global comparison of optical clocks. It's such an important and impressive achievement that it really brought together labs from across the world," says Alexander Aeppli at the University of Colorado Boulder, who helped build the world's best optical clock.

This story begins long before anyone was using lasers and vibrating electrons to tell time. In order to keep time accurately, we have always had to set our clocks by the ticks of a better one. Until the 1950s, the best were those set by astronomers based on the position of the sun in the sky. Back then, the most reliable clock was the one at the Royal Observatory in Greenwich, London.

ROBERTO CIGNA

Not everyone could bring their clocks to the observatory to set them, though – and that is where Ruth Belville, the "Greenwich Time Lady", came in. Every day, come rain or shine, she would take her stopwatch to the Royal Observatory, then travel all over London so her hundreds of clients could synchronise their timepieces with hers.

It is now 85 yers since Belville retired, and in that time this synchronisation process has become both easier and harder. For the most part, nobody has to trek through the London drizzle to bring anyone else the time – it can be transmitted through fibre-optic cables or satellites with enough precision for nearly any purpose. As things stand today, the official definition of a second is based not on the motion of the entire planet, but on the quantum vibrations of electrons in caesium atoms in what is known as an atomic clock. These vibrations happen with a fixed frequency. Measure this, and a simple calculation will yield the length of a second. "Frequency is the thing that humans have measured best," says Aeppli, so this is an unquestionably better way to measure time than anything that came before.

Caesium clocks aren't quite the best way to measure time we have, though. That accolade now belongs to optical clocks, which are also based on electrons jumping between quantum states. But the atoms used in optical clocks hop between these states much more quickly, making the clocks hundreds of times more accurate and precise.

Belville's watch was accurate to about one-tenth of a second, precision to a single-decimal place that seems almost laughable in comparison with the 15 or 16 decimal places offered by today's best optical clocks. Even if you waited for four times the current age of the universe, the optical clock riding down the motorway from Germany would be off by less than a minute. How times have changed.

"I've been involved with atomic clocks for over 20 years now, and by 2015 it became clear that optical clocks were getting better than the caesium clocks that are used to define the second currently," says Jérôme Lodewyck at the Paris Observatory in France. That renders the current definition obsolete, he says. And the International Bureau of Weights and Measures, which controls the world's clocks by setting the global standard for them – Coordinated Universal Time (UTC) – agrees: in 2022, it put forward a resolution to officially redefine the second using optical clocks.

Travelling timepieces

So why is our global timekeeping system still based on clocks that are second best? That comes down to the difficulty of building and operating optical clocks, plus the even more vexing problem of comparing them with each other. There are fewer than 100 optical clocks in the world, and before we can use those timepieces to officially redefine the second, researchers must be absolutely certain that each one is functioning at its peak.

Scientists have seen this coming for a good while and they knew that the only thing that can test one exceptional clock is another exceptional clock. One of them is Christian Lisdat at the Physikalisch-Technische ›

Bundesanstalt (PTB), the German national metrology institute. So, more than a decade ago, he and his team started hatching a plan to put their clock on the road. The idea was to pack it into a trailer and take it to the National Physical Laboratory (NPL) in Teddington, London, to meet another of the world's best optical clocks.

They recognised that such a journey, while anxiety-inducing, was absolutely necessary: there is no other way to meaningfully compare optical clocks across the globe without introducing errors that would drown out the precision we are trying to measure. Researchers have tried using satellites and fibre optics, among other potential methods to send signals between clocks, but everything they tested introduced far too much uncertainty. "We're really back to the situation that we had in the olden times, where, to do a comparison of clocks, you had to carry around a clock," says Michael Wouters at the National Measurement Institute in Australia. It is time for a modern-day Greenwich Time Lady.

But while Belville's pocket watch was a small, hardy thing, an optical clock is anything but. "These are quite complex apparatuses with a lot of vacuum systems and lasers and frequency stability," says Lisdat. "If you kick this stuff around too hard, there's a big chance that something breaks."

For the whole thing to work, the laser light in the clock's guts must be patterned just right for each strontium atom to sit undisturbed in its own spot in a neat grid, similar to eggs resting in an egg carton. Taking it on the road was like loading these fragile quantum "eggs" onto a trailer and hoping that their carton, made from something as ethereal and finicky as light, will never crease, fracture or dent. "I had knots in my stomach when I worked on similar measurements," says Fritz Riehle at PTB.

Despite their apprehension, in 2023 the PTB researchers loaded their 800-kilogram clock into an air-conditioned trailer, hired a professional driver to shepherd it through the European countryside, then hit the road. "Seeing the clock leaving PTB was quite a thing. [At that point] you know that now things will start, no matter if you are well prepared or not," says Lisdat.

The German clock wasn't the only one making the trip to London. At the same time, a team at the Japanese scientific institute RIKEN was preparing its clock for an even longer journey, this one by air (see "A clock caper", below). The researchers spent years miniaturising their equipment, making

"When we compare clocks, there are always surprises"

sure the lasers could be kept stable and the whole thing carefully packed and shielded to stay intact despite any disturbances to its environment during its long flight. "It arrived packaged into big wooden crates and was moved about with forklift trucks and transported on lorries from the airport," says Ian Hill at NPL. "Care was taken, but it got thrown around a little bit."

When the two visiting clocks arrived, they were hooked up to NPL's optical clock. This was a more standard device, its many components neatly arranged on a table in a laboratory. Its stationary and stable nature made it an ideal comparison for the potentially more fickle travelling clocks.

At NPL, each one was hooked up to a laser with the frequency of its light carefully locked to that of the main laser for the stationary clock, and those coupled lasers were used to measure the performance of the clocks. For three weeks, they ticked silently away, their frequencies monitored by laser light.

At the end of the experiment, the researchers couldn't immediately declare success – much of the data they had collected from the clocks still had to be analysed – but morale was high. They all went to a local curry house for a celebratory meal and immediately started talking about doing it all again.

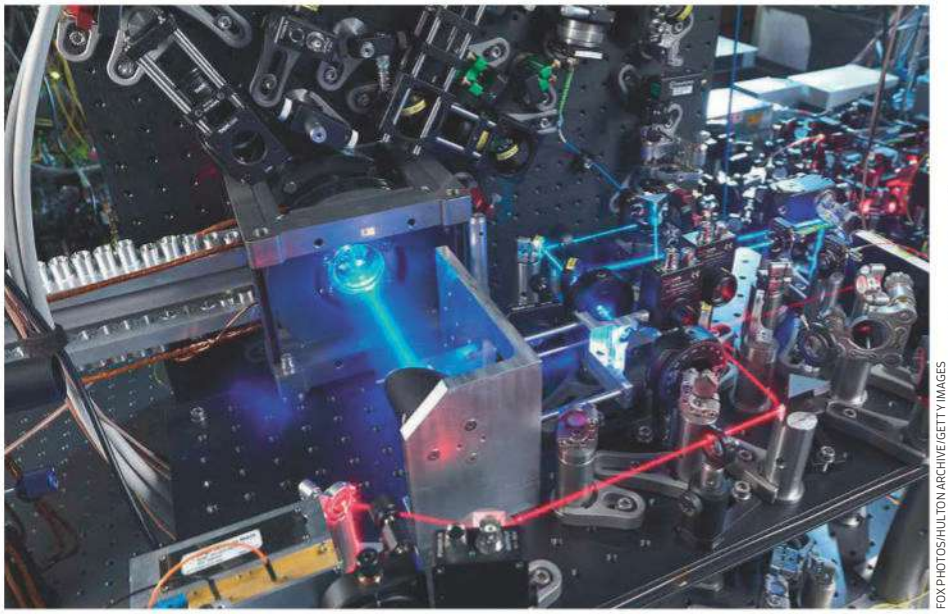
For some of the team, the next trial was imminent. After meeting in Teddington, the German and Japanese clocks made another journey, this time across the English Channel and through northern Europe to Braunschweig, Germany, for another comparison with a different laboratory-bound optical clock.

Another three weeks later, with all the comparisons done, it was time for the researchers to finally analyse their hard-won data. For the most part, the results were positive. The measurements taken in Germany were effectively identical to those collected in the UK, which was the researchers' main concern. This shows that optical clocks can travel widely and still tick along at the same rate as when they started – the largest hurdle we have to leap if we want to use them to redefine the second.

"This marks an important milestone for transportable clocks, demonstrating their potential as practical, real-world devices," says Hidetoshi Katori at RIKEN. The German travelling clock and the British stationary clock agreed remarkably well, as did the Japanese travelling clock and the German stationary one, showing statistical differences on the

A clock caper

The advent of super-precise optical clocks offers a chance to redefine the second, but work on this meant physically bringing these delicate timepieces together. One clock from the RIKEN research institute in Japan (1) and another from Germany's national metrology institute (PTB, 2) journeyed to a third at the UK's National Physical Laboratory (NPL, 3).



GUIDO WILPERS/ANDREW BROOKES AB STILL LTD

FOX PHOTOS/HULTON ARCHIVE/GETTY IMAGES

Optical clocks like the one at the National Physical Lab in London (left) are a long way from the watch once used to synchronise the city's clocks (below)

order of just 1 part in 1 million trillion. In fact, the level of agreement between the latter pair was the best ever achieved among independent clocks of the same kind. All of the optical clocks emerged from the experiment as battle-tested champions of timekeeping.

But there were complications too. "When we compare clocks, there are always surprises that they don't quite agree or behave as expected – always," says Hill. While some pairs of clocks agreed exceedingly well, the whole group of four showed some surprising discrepancies.

Testing gravity

The researchers haven't yet figured out where these discrepancies in frequency come from – whether there is a problem with the temperature of the atoms fluctuating or perhaps an unexpected interaction between the electrons in those atoms and the laser beams. "That's really the point, to find out these discrepancies and to understand where they come from," says Lodewyck.

Even if there is still some work left before we can use optical clocks to redefine the second, there is another problem that they could start solving now: measuring the minuscule changes in Earth's gravity field that can be caused by shifting sea levels or seismic activity.

According to Einstein's general relativity, clocks that are closer to the ground tick slightly more slowly than those that are higher up because of the pull of gravity. "Depending where you are in the gravity field of Earth or a black hole or whatever, your time passes at a different speed," says Lisdat. "That's what you see if you compare clocks at different height." The effect is so minuscule that regular clocks simply cannot measure it. For example, a clock raised 1 centimetre above another one will tick 0.0000000000000001 per cent more quickly.

Luckily, this is exactly how precise optical clocks typically are, so carting them around all sorts of terrain could help map Earth's surface and the details of its gravitational field like never before. The researchers tried using their clocks to determine the height difference between the two labs they visited and found that they performed as well as the best methods that experts currently use, showcasing precision to within less than 4 centimetres – and this was after they had been lugged around the world.

"There have been some proposals to put a network of [optical] clocks around a volcano to determine when it's going to erupt. Or put it near some subducting tectonic plates and determine when the next earthquake will happen," says Aeppli. These clocks would detect the tiniest of changes in the vertical position of the ground, which could then be identified as the early rumblings of an earthquake or a volcanic eruption. Such a network could even prove useful for testing general relativity itself through careful examinations of how gravity affects their ticking.

But the most important step forward from the clocks' journey is towards redefining the second – a goal that researchers are aiming to hit by 2030. That achievement will echo throughout science because of how fundamental the second is to many types of measurements, whether it be evaluating the brightness of light, the temperatures of celestial objects or even the amount of current in electronics. If you think of these measurements as our way to paint a picture of the world, how far you can zoom in to that picture before encountering fuzzy, uncertain edges is more often than not determined by how well we can define the second. A more precise definition of the second will mean a more precise picture of the world. Japan has had a head start on this: since June 2021, Japanese Standard Time has been calculated based on both a caesium clock and an optical clock, albeit with far less stringent accuracy requirements than those in place for doing such a thing globally – it is easier to redefine one time zone than to reset all of them.

"This quest [to redefine the second] is epic. We did something towards that," says Hill. "We perhaps also revealed that a large amount of work is still required to reach the criteria to redefine. And so we continue." As for the PTB researchers, Lisdat says they are getting their clock ready to travel to Italy for another comparison right now. It will take many more journeys like this one for us to be sure that optical clocks are reliable enough to form the foundation of global timekeeping.

This is the thing that all the researchers agree on the most: more optical clocks ought to be driving on highways, flying through cloudy skies and ultimately getting to sit next to the only other devices on Earth that keep time as well as they do. The first step on the road was certainly a success – the Greenwich Time Lady would no doubt be proud. ▮

Karmela Padavic-Callaghan is a physics reporter for *New Scientist* in New York

The back pages

Puzzles
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Feedback
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Picturing the lighter side of life p48

Dear David

Avoiding the doomscroll

Do you find yourself drawn to reading bad news? Resident advice columnist **David Robson** has some science-backed tips to help

David Robson is an award-winning science writer and author of *The Laws of Connection: 13 social strategies that will transform your life*

Further reading

If you are looking for further ways to improve your social media exposure, this piece from Harvard Medical School offers some eminently practical tips: bit.ly/41D2yZP

You may also enjoy Alain de Botton's *The News: A user's manual*

Dear David appears monthly

Next week

Stargazing at home

WITH the fractious state of global politics, it is little wonder that one reader has written in to say they are overwhelmed by bad news. "I know it's bad for my mood, but I can't stop myself reading about the disasters unfolding," she says. "How can I find mental peace when there's so much wrong in the world?"

I'm sure many of us can empathise; doomscrolling is a common habit caused by the human brain's preference for negative information. When presented with various headlines, our attention naturally fixes on the most depressing or frightening. One recent study found that each negative word in a headline adds 2.3 per cent to the average click-through rate. Doomscrolling appears especially common in people with low "tolerance of uncertainty" – those who want a predictable future they can control.

Our negativity bias might have served us well in the past, when our survival depended on our capacity to understand and respond to threats. But it may be ill-suited to the 21st century, when the dangers of the world are beamed onto our devices' screens 24 hours a day. Doomscrolling has been linked to a higher risk of depression, and, in some people, excessive media consumption about distressing news events can produce the symptoms of PTSD.

If you find your news consumption damaging to your well-being, you might choose to temporarily disengage from your feeds, or at least limit your exposure to a fixed period. In cognitive behavioural therapy for anxiety, clients are often told to assign themselves a limited "worry time" each day, after which they are encouraged to look for distraction. The chance to anchor such anxious rumination to a fixed period appears to be more effective than simply telling someone not to worry at all.

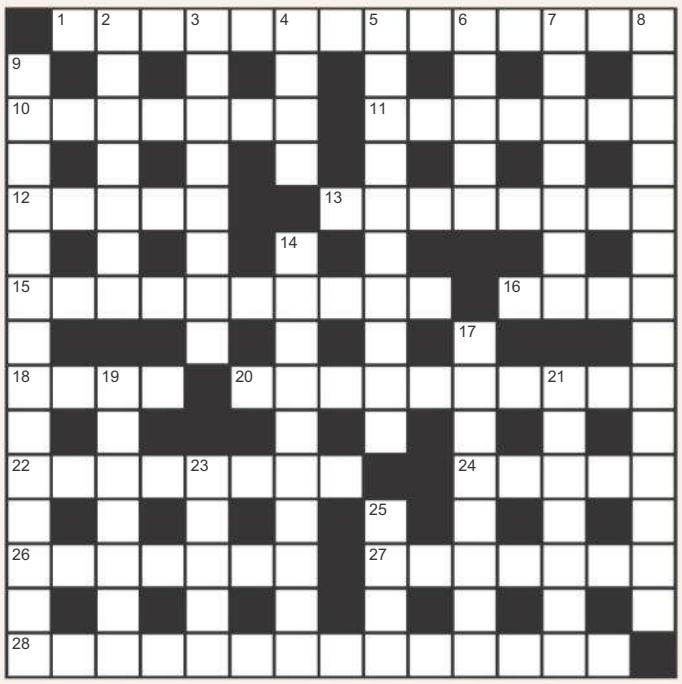
FIORDALISOMOMENT RF/GETTY IMAGES

You might also make a conscious effort to find items that restore your faith in humanity. A recent study by psychologists Kathryn Buchanan and Gillian Sandstrom asked people to watch footage about the Manchester Arena bombing that happened in May 2017. They found that showing some examples of brave and altruistic responses to the attacks helped to reduce participants' distress and cynicism. They were more likely to respond positively to statements such as "people are basically good" and "the way our society works makes sense", for instance.

Of course, we shouldn't aim to sugarcoat every troubling event so that we no longer feel any fear or anger. But by bolstering our resilience, we may become more motivated to take positive action. A follow-up study by Buchanan and Sandstrom found that people who watched others' kindness were more willing to act pro-socially themselves. The world may be a dark place, but we can choose to look for the light. ▮

These articles are posted each week at newscientist.com/maker

Quick crossword #180 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Euler and Erdos, say (14)
10 Eight-limbed mollusc (7)
11 Device for pushing atmospheric gas (3,4)
12 Combine (5)
13 Disconnection device (8)
15 Retrieval of information (4,6)
16 Amazon palm (4)
18 Louse eggs (4)
20 Vitamin B_2 (10)
22 Eoraptor or tyrannosaur, for example (8)
24 Flight fin (5)
26 Raise; increase (7)
27 Tiredness (7)
28 Sunburn (8,6)

DOWN

2/9 Warning concerning Europa, in the *Space Odyssey* series (7,2,7,5)
3 Beneath an axis (of the spine, particularly) (8)
4 M (4)
5 Circuit component (10)
6 Polyp structure (5)
7 Water-dwelling (7)
8 RS Puppis or Rigel, perhaps (10,4)
9 See 2 Down
14 Starfish, say (10)
17 Device for storing rotational energy (8)
19 Through the means specified (7)
21 Weak acetic acid (7)
23 Saltbush (5)
25 Red planet (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #296
set by Corryn Wetzel

1 What is the world's largest freshwater lake by surface area?

2 In electronics, what does USB stand for?

3 Which frog is considered the most poisonous in the world?

4 Which space mission provided the first detailed images of Pluto's surface?

5 What are plants adapted to salty ecosystems known as?

Answers on page 47

BrainTwister
set by Colin Beveridge
#67 Pandigital sums

A pandigital sum is an addition that uses each of the digits from 0 to 9 exactly once, and no number within the sum starts with a zero. For example, 4927 + 86 = 5013 can be represented as ABCD + EF = GHIJ, where each letter is a different digit.

There are 36 pandigital sums of the form ABCD + EF = GHIJ. Can you find one where GHIJ = 2034?

There are 96 pandigital sums of the form ABC + DEF = GHIJ. How many can you find where GHIJ = 1089?

There is one pandigital sum of the form ABC + DEF = GHIJ where A < B < C < D < E < F. Can you find it?

Solution next week

Mug mystery

Why is tea more likely than coffee to leave a stain in the cup?

Chris Daniel
Glan Conwy, Conwy, UK
Tannins are complex, water-soluble organic compounds found in a wide range of plants, including tea and coffee. They are a type of polyphenol with antioxidant and anti-inflammatory properties, and are known for their bitter flavours and astringency.

In "hard water" areas, water contains more calcium hydrogen carbonate. When heated, this compound breaks down into calcium carbonate and water, forming limescale that coats the inside of mugs, kettles and teapots. Tannins from tea or coffee bind to the calcium salts in water to form an insoluble precipitate that floats to the surface.

The floating precipitate disperses towards the upwards-sloping meniscus at the edge of the drink, from which it is deposited onto the wall of the mug as the liquid is consumed. If the drink is left for long enough that it starts to slowly evaporate, the precipitate can accumulate, forming an unsightly ring around the inside of the mug.

"Tea contains more than twice as many tannins as coffee, so it will stain a cup more readily"

Tea contains more than twice as many tannins as coffee, so it will stain a cup more readily. However, as tea and coffee lovers know, mugs used regularly for either drink will eventually need a good scrub to get rid of the brown stains.

Sam Edge
Ringwood, Hampshire, UK
Tea contains far more tannins than coffee does, which bind with other molecules in the water to form precipitates that will adhere to porcelain, metal and even glass.

Tea is also usually steeped at a high temperature for several minutes before being drunk, giving the ingredients more time to stick to surfaces.

For readers wanting to rid their mugs of these stains, the easiest way is to fill the cup with boiling water and add a teaspoonful of baking soda or bicarbonate. Leave the spoon in the mug so it gets the benefit of this too, and wait for an hour or so. You will find the stain then washes off much more easily.

On the other hand, some people will call you a heretic, particularly if you do this to a teapot, as they claim that the accumulated stains add to the flavour of the brew.

BABAROGA/SHUTTERSTOCK

Why does water never travel in straight lines?

This week's new questions

Way of water **Why does water never move in straight lines? Even running down a windowpane, it wiggles. Is there any explanation for this?** ***Bobby Bazalgette****, Carmarthen, UK*

Fancy feast **When did hominids start to decorate their food and do any other species do the same?** ***Andrew Murray****, Moore, South Carolina, US*

In the clouds

What happens to our electronic cloud records when we die? (continued)

Simon Ritchie
Leatherhead, Surrey, UK
In many cases, what happens with your data is entirely up to the companies that hold it. Free services such as social media providers make money off of your data, so they will keep it for as long as possible. Because maintaining stored data is expensive, a lot of other services will just discard it.

Unless you have left a record of your password, your heirs won't be able to access your emails, so anything not stored on your computer will effectively be lost immediately. Services that need to be secure, such as online payment systems, are increasingly using some form of two-factor authentication involving the ability to receive a text message or run a mobile phone security app. This is fine until you die, at which point your heirs won't know your passwords or may close your mobile phone account before they discover that they need it to access data that they have only just found out about.

Does it hurt?

Plants wither away when they don't receive enough water and sunlight. Can they also feel pain as a result?

Matthew Stevens
Sydney, Australia
The short answer is no, plants cannot feel pain. Pain is an experience that provokes an instant response to avoid the cause of the pain. This evolved in animals because it gives a survival advantage: remove yourself from the cause of the pain and live to see another day.

If plants ever evolved the capacity to feel pain, they would also need the capacity to avoid the cause of their distress. For plants that are rooted to the spot, that is nigh impossible. A plant species that devoted resources to building pain receptors and developing avoidant behaviours could, for example, be outcompeted by plants that don't feel pain and put the same resources into making more seeds.

This isn't to say that plants can't feel sensations at all: numerous observations and experiments show that plants respond to touch, such as *Mimosa pudica* and tendril vines. When nibbled, many plants release volatile chemicals that alert other parts of themselves and other plants. This triggers them to produce defensive chemicals, which are expensive to make

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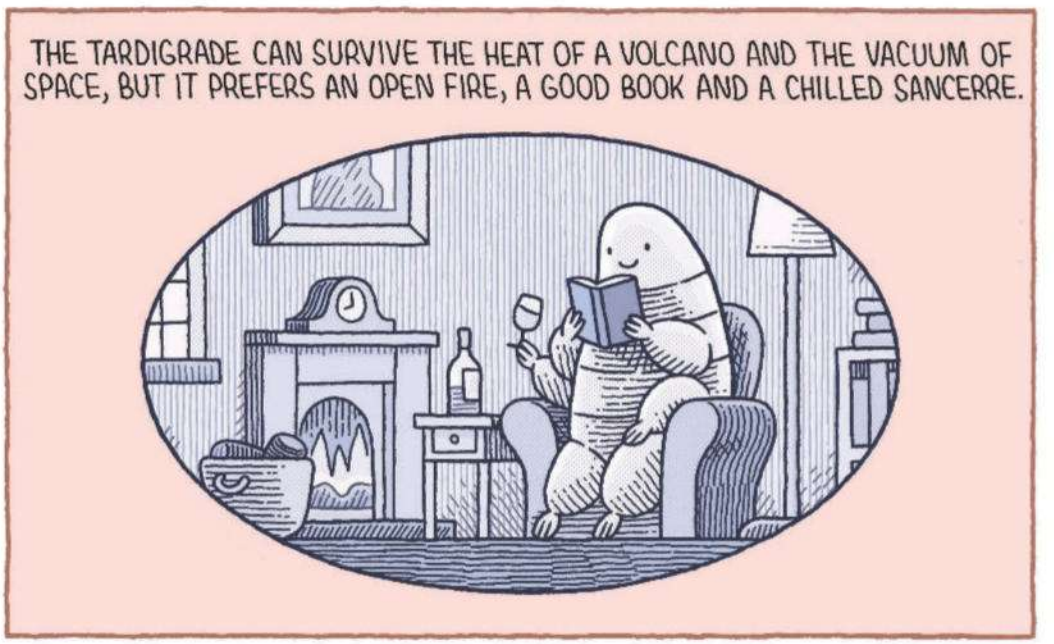
Tom Gauld
for New Scientist


THE TARDIGRADE CAN SURVIVE THE HEAT OF A VOLCANO AND THE VACUUM OF SPACE, BUT IT PREFERS AN OPEN FIRE, A GOOD BOOK AND A CHILLED SANCERRE.

in the absence of predators.

In short, there is no survival advantage for a plant to be able to feel pain if it can't take action to avoid the harm. Developing tough, spiky or distasteful features is a much more likely advantage than developing motility.

Mike Follows
Sutton Coldfield, West Midlands, UK

Researchers have long recognised the survival value of pain, with many animals experiencing it and responding accordingly. While plants don't have nervous systems like animals do – meaning they cannot feel pain in the way we understand it – they do have mechanisms that allow them to respond to environmental stress.

For example, while plants cannot move when they detect a lack of water, they may close their stomata (the pores on their leaves) in order to retain more moisture.

Plants can also release chemicals to warn nearby plants about threats like herbivores. The compound we recognise as the scent of freshly cut grass, for instance, is part of a larger group of chemicals called green leaf volatiles. These are volatile organic compounds that diffuse easily through the air and provide a chemical function somewhat similar to the pheromones used by many animals.

"It is important to recognise that pain isn't merely a detected signal; it is sensed by the nervous system, which plants lack"

Recently, scientists have uncovered the existence of extensive mycorrhizal networks, symbiotic associations between plants and fungi that are a key part of what has come to be called the "wood wide web". Fungi form symbiotic relationships with the plants' roots, creating connections between different plants and trees that facilitate the exchange of nutrients, water and chemical signals between them.

When plants are disturbed, whether by a bug bite or a mechanical injury, they release glutamate, an amino acid that activates receptors and triggers a "calcium wave". This ripple of calcium spreads throughout the plant. Intriguingly, this is similar to the role that calcium plays in humans, signalling between neurons during stress or pain.

The way that plants respond to threats or damage is understood as a survival mechanism based on biochemical processes, but it doesn't include the emotional or sensory experiences we associate with pain. For a long time, it was thought that insects didn't experience pain either, and while it is now accepted that some do, this doesn't mean we should think this will automatically extend to plants as research advances.

Pain isn't merely a detected signal; it must be sensed by the nervous system, which plants lack. Pain evolved to alert us of potential damage, but since plants can detect damage without sensing pain, they aren't significantly disadvantaged. ▮

Answers

Quick quiz #296 *Answers*

1 Lake Superior, North America
2 Universal Serial Bus
3 Golden poison dart frog (*Phyllobates terribilis*)
4 New Horizons
5 Halophytes

Cryptic crossword #158 *Answers*

ACROSS 1 Ling, **3** *Toy Story*, **9** Ferrous, **11** Liege, **12** Sombre, **14/10** Spirit level, **16** Adverb, **19** Techno, **21** Bight, **24** Actin, **25** Telford, **26** Gradient, **27** Onus

DOWN 1 Lifeless, **2** Nurse, **4** Obsess, **5** Salem, **6** Obverse, **7** Yell, **8** Do-re-mi, **13** Ebb tides, **15** Inertia, **17** Dabble, **18** Top ten, **20** Hindi, **22** Groin, **23** Gang

#66 Easy times? *Solution*

To get from 15 to 51, multiply 15 by 3.4.

135 × 2.6 = 351. Moving a digit from the front to the back is the same as multiplying the smaller number by 10, subtracting 1000 and adding 1, so we can write 10n – 1000 + 1 = 2.6n, where n is the number you are moving a digit of, and solve this equation.

12,195 × 1.8 = 21,951. Here, a similar formula is used, but instead of 1000, we subtract 100,000.

123,456,790 × 1.9 = 234,567,901.

In general, if n is a d-digit number, with f as the first digit, then moving its first digit to the opposite end gives the number 10n – (f × 10d) + f = m × n, where m is a suitably chosen multiplier.

Streisand strikes again

Some things are sadly inevitable: death, taxes, another Coldplay album. One such inevitability, long since proved beyond any reasonable doubt, is that if you try to suppress an embarrassing story, you will only draw more attention to it.

This phenomenon is called the Streisand Effect, after an incident in 2003 when Barbra Streisand sued to have an aerial photograph taken off the internet. The shot was part of a series documenting coastal erosion in California, but identified her cliff-top mansion. She lost, and in the process drew public attention to the photo. Having previously been downloaded six times (twice by her lawyers) it was then accessed hundreds of thousands of times.

And so, with weary inevitability, we come yet again to Meta, Mark Zuckerberg's personal empire encompassing Facebook, Instagram, Threads, WhatsApp and a sizeable chunk of Hawaii. In March, Sarah Wynn-Williams – Facebook's former director of public policy – put out a memoir of her time at the company, which has the Gatsby-esque title *Careless People*. Feedback isn't going to repeat the specific allegations in it, because Meta has very high-powered libel lawyers and we don't want to be responsible for *New Scientist*'s in-house lawyers all dropping dead of heart attacks. Suffice it to say, it is a real page-turner.

Meta responded by taking legal action. By leveraging a non-disclosure agreement Wynn-Williams had signed when she left the company, Meta prevented her from promoting *Careless People*. Any interviews you may have seen with her were conducted before Meta obtained the injunction.

The result? The book has become a global bestseller, and you just read about it in the silly bit at the back of *New Scientist*.

Offensive Paridae

Feedback recently told the story of researcher Nicolas Guéguen, who has had some of his papers retracted – including one about the advantages of having large breasts while hitchhiking – as the result of investigations by data sleuths Nick Brown and James Heathers (15 March).

So we were naturally intrigued to get an email from Brown, who came across our coverage because he has "a Google alert set up for 'Nicolas Guéguen'". We wondered if we might have got a detail wrong, or otherwise bungled the story.

However, he was writing in response to another item in the same column. This related to the perennial Scunthorpe problem: the fact that completely innocent words can contain letter strings that are offensive in isolation, so the automated systems that block questionable words often catch harmless ones in their nets.

"Before I became a scientist I worked in IT," explains Brown. "Maybe around 1999, someone came to me with a question. Her email to the Royal Bank of Scotland had bounced, and the rejection notice literally said this: 'Reason: Dirty Word: TITS'."

Readers: take a moment to recover from the shock. We too were stunned that the automated system used the phrase "dirty word": we didn't realise RBS's systems were based on primary school behaviour guidance.

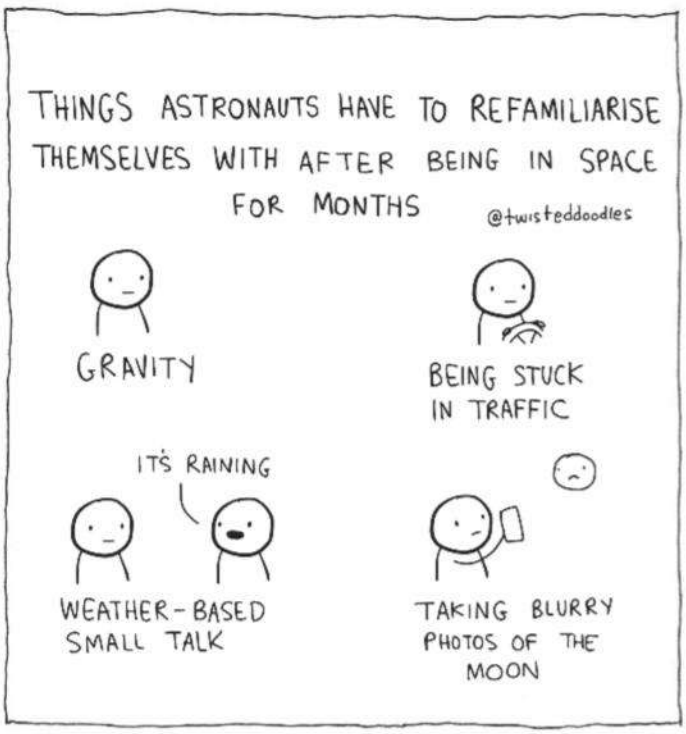
Brown examined the message, "which was entirely innocuous and contained no reference to birds of the Paridae family". Then he used a text editor to look at the email header, and there he found the "dirty word".

"We were in France and used names from the *Asterix* comics for our servers," says Brown. "One of the mail servers that the message had passed through was named 'Petitsuix'." This is an innkeeper who appears in three *Asterix* volumes: his name is a parody of petit-suisse cheese, if you didn't get that. So, says Brown, the email header "contained something like 'Via:Petitsuix.domain.com', thus bumping up against the Scunthorpe problem".

This led Brown to wonder what might have happened if, by some infernal coincidence, his employers had been using the same anti-spam software. "Would our spam filter server have replied with 'You said "tits"', and then they would have come back with 'No, you said "tits"', and so on for ever?"

So what happened next? "I remember saying at the time, 'Well, clearly that bank is going to go bust'," says Brown. He had to wait until 2008 – and legally Feedback has to say that despite the glory of Brown's pun, that didn't happen: the government bailed the bank out.

Twisteddoodles *for New Scientist*


THINGS ASTRONAUTS HAVE TO REFAMILIARISE THEMSELVES WITH AFTER BEING IN SPACE FOR MONTHS
@twisteddoodles
GRAVITY
BEING STUCK IN TRAFFIC
ITS RAINING
WEATHER-BASED SMALL TALK
TAKING BLURRY PHOTOS OF THE MOON

Got a story for Feedback?
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or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Queued up

Sometimes, Feedback comes across a solution to a problem that is simultaneously brilliant and rock-stupid. Such a solution was brought to our attention by reporter Matthew Sparkes.

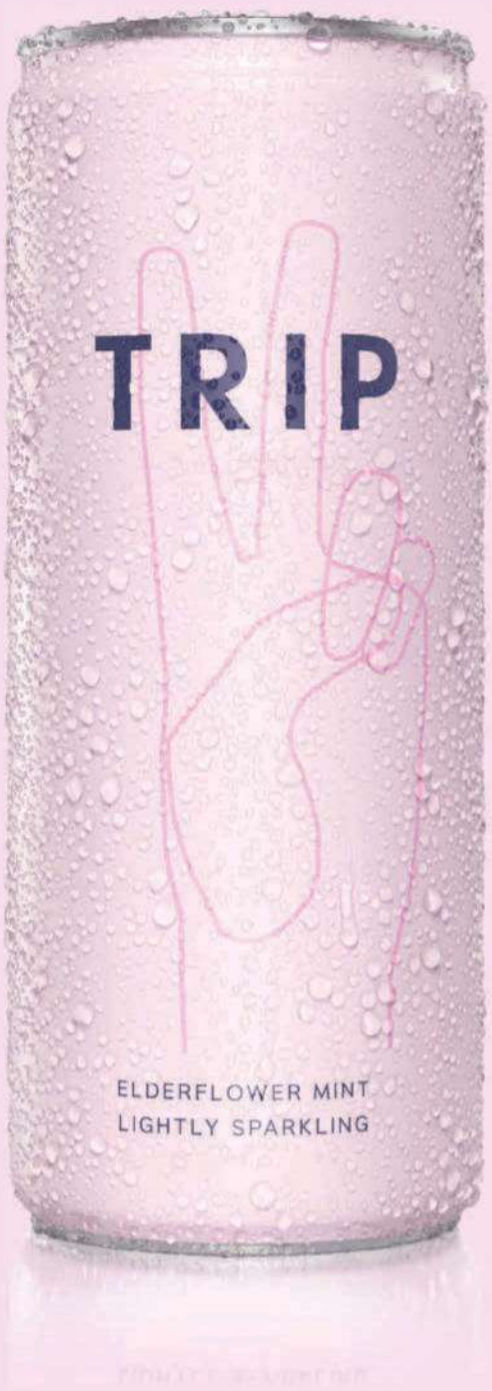
Three researchers were trying to make queueing less deadly dull, so they developed a robot for people in queues to play with. As they explained, the robot is called "Social Queue". It is "a robotic stanchion pole with a responsive tentacle on top that interact[s] with people through three modes of interaction, 'Attracting', 'Escaping', and 'Friendly'." Apparently, this "enhanced people's enjoyment".

Feedback isn't a roboticist: not out of an utter lack of technical ability – perish the thought – it is just that we saw *Battlestar Galactica* and decided not to be complicit in the robot apocalypse. Still, this sounds like a feat of engineering.

But we did wonder why anyone would go to the bother of designing a queue robot, when you could just set up a timed-entry system and eliminate the queue.

TRIP

Calm is just a can away



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